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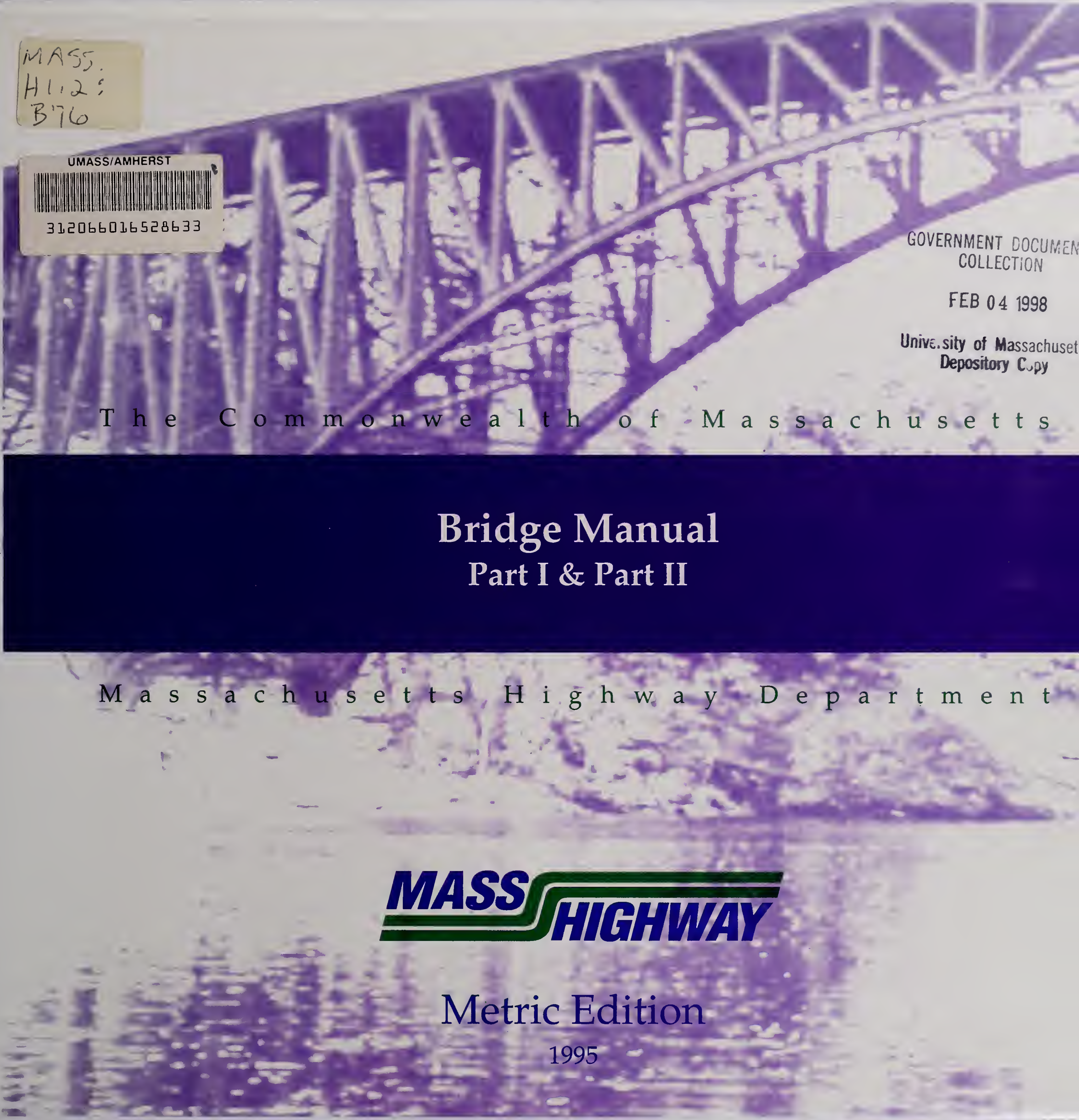

The Commonwealth of Massachusetts

Bridge Manual
Part I & Part II

Massachusetts Highway Department

MASS HIGHWAY

Metric Edition

1995

The Commonwealth of Massachusetts

William F. Weld
Governor

Argeo P. Cellucci
Lieutenant Governor

James J. Kerasiotes
Secretary of Transportation

Laurinda T. Bedingfield
Commissioner

MASS HIGHWAY

Prepared by
The Massachusetts Highway Department

1995

MASS HIGHWAY
Office of the Commissioner

William F. Weld
Governor

Argeo Paul Cellucci
Lieutenant Governor

James J. Kerasiotes
Secretary

Laurinda T. Bedingfield
Commissioner

November 1995

Dear Reader:

Bridges have been an integral and vital part of the Massachusetts and national economy as far back as the Battle of Lexington and Concord. As transportation, technology and the economy have evolved, one constant that has remained is the role that bridges play in keeping the world moving.

The 1995 Massachusetts Highway Department Bridge Manual - Metric Edition has been designed as part of the Weld - Cellucci Administration's and MassHighway Department's commitment that the Infrastructure of Massachusetts be *retrofitted, revolutionary and ready* to meet the challenges of the New World Economy as well as the needs of the 21^{ST} Century.

To accomplish this, we have joined in partnership with Industry and Academia to develop a comprehensive mission known as the **Massachusetts Quality Initiative (MQI)**. The MQI includes: The Bridge Quality Partnership, Partnering, Total Quality Management, Value Engineering, Employee Education and Training, The Pavement Quality Partnership, and Quality Control/Quality Assurance.

This Metric Edition of the Bridge Manual represents an important first step in the *Bridge Quality Partnership*. As part of the metrication effort, the previous Bridge Manual was revised and updated to current practice through a cooperative partnership with PCI New England and AISC. Likewise, the metrication of details and dimensions anticipates a Metric America by following a hard, rational metric conversion. By doing so, it will ease the implementation of the metric system by giving bridge designers, inspectors and construction personnel dimensions that are easy to use and remember.

I hope that every reader finds this Bridge Manual to be a *valuable tool and reference*. Since *Teamwork* and *Partnership* are Standards of MassHighway, I invite you to participate, to comment and to be part of our Commonwealth's continual improvement.

Very truly yours,

Laurinda T. Bedingfield
Commissioner

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MASS HIGHWAY

BRIDGE MANUAL - PART I

MASSACHUSETTS HIGHWAY DEPARTMENT

BRIDGE MANUAL

PART I

DESIGN GUIDELINES

Metric Edition

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BRIDGE MANUAL
PART I: DESIGN GUIDELINES
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CHAPTER 1
BRIDGE SITE EXPLORATION

1.1 SURVEY FOR BRIDGES

1.1.1 General

The following are the minimum survey requirements for bridge projects and the basic reasons for them. Additional survey beyond these requirements may be needed depending on the complexity of either the proposed bridge structure or the site.

1.1.2 Bridge Grid Survey

The bridge grid is taken in order that the proposed bridge may be fitted to the topography and an accurate calculation can be made of excavation quantities. It shall be plotted to either 1:100 or 1:50 scale. The frequency of shots and extent must be a matter of judgment of the survey party. In general, shots should be taken on a 4 meter grid with additional shots as necessary for abrupt changes in contour. They should extend at least 20 meters beyond the edges of the highway or 8 meters beyond the anticipated end of splayed wingwalls, whichever is furthest, and should cover enough ground for any type of structure. The grid should be extended to reflect topography under existing structures.

1.1.3 Bridge Detail Survey

The following survey information should be requested when: a new superstructure is to be built on existing substructures; an existing bridge is to be widened; an existing bridge is to be repaired or rehabilitated or the deck is to be replaced. The accuracy of surveys on bridge locations should be greater than on general highway work.

1. The angles of the abutments with the baseline, the location of tops and bottoms of batters, the widths of bridge seats and backwalls, the location of the angles of the wingwalls with abutments, the length of wingwalls and widths of copings should be measured and the footings located if possible. The type of masonry in the substructure and its condition should be noted.

2. The extent of detail to be taken on the superstructure is largely a matter of judgment. In all cases the general layout; such as curbs, trusses, girders, fences, sidewalks, utilities, copings, ends of bridge, etc., should be located. The stations of the centerlines of bearings and the skew angle between them and the survey baseline should be established or verified.

3. For rehabilitations where the existing beams are to be retained, bottom of beam elevations should be taken on every beam at: the face of each abutment, both sides of each pier and span quarter points for spans less than 15 meters, span eighth points for spans over 15 meters. These elevations are needed for calculating the depth of haunches and top of form elevations.

4. Elevations should be taken of all parts of the substructure and superstructure, such as the bridge seats, tops and ends of wingwalls, gutters, top of curb at intermediate points and at the ends of curbs, tops of slab and footings, if possible. All levels should be referred to the North American Vertical Datum (NAVD) of 1988, unless only the National Geodetic Vertical Datum (NGVD) of 1929 is available at the site.

5. Locate and establish the minimum horizontal and vertical clearances of the existing structure.

1.1.4 Additional Survey for Bridges over Railroads

Whenever a railroad is crossed, the railroad baseline should be reproduced and sections taken a minimum of 16 meters perpendicular to and on both sides of the exterior rails for a distance of about 100 meters left and right of the survey baseline.

1.1.5 Survey for Stream

The stream shall be surveyed for a distance up and downstream of at least 150 meters either side of the baseline. Elevations should be taken on a 4 meter grid. Any tributary entering the stream near the bridge site, either above or below, shall be surveyed for a distance of at least 150 meters from its junction. Locations and size of visually accessible drain pipes should be noted. Where there is any possibility of a relocation of existing stream, adequate survey shall be taken to encompass the relocation.

If there is a dam or other water flow control device within 500 meters either up or down stream, the survey shall include: its distance from the bridge; elevations of the spillway, the top of the dam, water and riverbed soundings both upstream and downstream of the dam.

1.2 BORINGS FOR BRIDGES

1.2.1 General

No structure can be stronger than the founding of its substructure elements. Borings are taken for these elements and the study of the results and samples aids in the determination as to the type of foundation support.

In the preparation of the basic design report, generally at least one pilot boring is taken for each structure and is recorded in that report. If the location of the structure is firmly fixed, pilot borings are generally not necessary. After the basic design report is accepted or approved, the next step for subsurface exploration is the preparation of a design boring plan for each structure.

1.2.2 Boring Plan

Boring plans for bridges shall be prepared as outlined in Section 1.3 of Part II of the Bridge Manual. They will be drawn on a single sheet of paper no smaller than A4 and shall contain the following information:

1. The standard title block (Drawing 1.3.1 of Part II).

2. A 1:500 plan view of the proposed structure, with the boring locations indicated by the standard symbol and a table indicating: boring number, station and offset from baseline, and specified highest bottom elevation (drawing 1.3.2 of Part II).

3. Boring Request Notes, from Drawing 1.3.3 of Part II of the Bridge Manual, and modified as indicated on the drawing.

Seven (7) copies of the boring plan shall be submitted to the Bridge Engineer. One copy will remain in the bridge file. Three (3) copies will be forwarded to Survey to lay out the boring locations in the field. Three (3) copies will be forwarded to Research and Materials for their use in taking the test borings.

1.2.3 Definitions

1.2.3.1 Pilot Borings. Pilot borings are those made during the preliminary stage of a project. These borings shall be located by the Design Engineer as scattered points, to yield only sufficient soil information to enable the Design Engineer to:

1. Prepare a type study
2. Fix the profile, alignment of the highway, and position of the structures.
3. Prepare a preliminary cost of the project.

1.2.3.2 Design Borings. Design borings are made to furnish all subsurface data and soil samples required by the Design Engineer to complete the design of the project. Design borings include control and complementary borings as defined below. These borings are to be made after the profile, alignment, location, and type of structure have been approved. Borings in the pilot set that fit into the pattern of the design borings shall not be duplicated.

1.2.3.3 Control Borings. Control borings are the initial design borings. The results obtained from control borings are reported immediately to the Design Engineer so that, at each area and location, the depth to which all remaining complementary borings should be taken can be determined.

1.2.3.4 Complementary Borings. Complementary borings are the remaining design borings required for design and construction purposes. They are made after an analysis of the results obtained from the control borings, to the depth specified by the Engineer. Usually, the Design Engineer and the Department's Geotechnical Section and/or Bridge Section jointly review the results of the control borings to determine the depths of the structural complementary borings. Generally, all bridge complementary borings are made. Complementary borings are not used for a pilot boring program.

1.2.4 Depth and Location

1.2.4.1 Pilot Borings.

Depth: For structures, the specified highest bottom elevation shall be set 3 meters below the preliminary footing elevation at the boring location. Each boring shall be made to the specified highest bottom elevation or to refusal, whichever is deeper. Refusal is defined as 120 blows for 300 millimeters of penetration by using the Standard Penetration Test (SPT). If rock is encountered above highest bottom elevation, a 3 meter rock core is taken and the bore hole is terminated.

Location: One boring per bridge site. Consideration of a rock core should be made at this time if rock would influence the foundation design.

1.2.4.2 Design Borings.

Depth: For structures, the specified highest bottom elevation shall be set 3 meters below the preliminary footing elevation at the boring location. For perched abutments, the specified highest bottom elevation shall be set 5 meters below existing ground. At least one boring shall be made to bedrock at each bridge site location. Where a viaduct of considerable length is to be designed, every other pier may have one boring made to bedrock, if deemed necessary by the Engineer. Where structure foundations may be pile or shaft supported, one boring shall be made to bedrock under each substructure unit.

Location: Borings shall be taken for every bridge, metal arch, box culvert with a span greater than 2.44 meters, retaining wall, and "highmast lighting foundation". Borings may be required for sign supports. For smaller structures, engineering judgment should govern.

One boring shall be made at each end of each pier or abutment and at the outer end of each wingwall more than 10 meters long. Where piers and/or abutments are more than 30 meters long, additional borings may be required.

For retaining walls up to 30 meters in length, at least one boring shall be taken at each end of the wall. For walls longer than 30 meters, borings shall be spaced no more than 30 meters apart. Wall borings shall be alternately control and complementary.

For culverts up to 15 meters in length, two borings will be required. For culverts longer than 15 meters, three borings will be required.

The preceding description is given as a guide and should not pre-empt sound engineering judgment. Likewise, the depth to which borings are carried may vary, depending on design requirements. Where utilities are present, the borings shall be accurately located no closer than 1.5 meters from the nearest edge of the utility.

1.2.5 Other Subsurface Exploratory Requirements

1.2.5.1 The additional subsurface explorations outlined below will be included as part of the boring program. Any laboratory test program on the recovered boring samples required by the Design Engineer which is to be done at an outside testing laboratory shall be approved by the Department before any work is done.

1.2.5.2 Under certain conditions, test pits may be needed to disclose certain features of existing structures that may be retained. Test pits shall be dug to establish the elevations of the top and bottom of the footing toe as well as the projection of the toe from the face of the abutment or wall. A minimum of two test pits shall be dug at each abutment, one approximately at each end of the abutment.

1.2.5.3 Exploratory probes will be taken, in conjunction with horizontal cores if required, for all abutments and walls which may be retained and for which accurate plans do not exist. These exploratory procedures are needed to determine the cross sectional geometry of the wall, such as width, batter and footing thickness, from which the re-use potential of the structure can be evaluated. Provisions for this type of investigation will be included as part of the boring program.

1.2.5.4 If a clay stratum or other compressive material is encountered, in-situ tests and/or undisturbed samples may be required for laboratory tests and analysis. Generally, this type of work is accomplished in the complementary boring program after the results of the control borings are reviewed.

1.2.6 Ground Water Observation Wellpoint

Ground water level as reported during a soil-test boring operation may not be accurate, since the water level in a test boring may not have had sufficient time to stabilize or may be affected by the use of water in the drilling process. When a study of the pilot or control borings indicates that an excavation in granular soil must be made below ground-water-level, observation wellpoints should be installed. Not more than one (1) observation wellpoint should be installed at a bridge except with prior approval of the Engineer. Unless otherwise directed, the bottom of the point shall be located approximately 3 meters below the proposed bottom of footing.

District personnel will measure and report water levels monthly to the Engineer, unless more frequent readings are required. This information is to be tabulated on the sketch plans and construction drawings (see Paragraph 2.5.3.3 for sketch plans and Paragraph 4.2.2.3 for construction drawings).

1.2.7 Inaccessible Boring Locations

Because of certain physical conditions, such as existing buildings, or because of problems with abutters, boring crews may have no access and certain borings specified for the structure cannot be taken. In such cases, the additional required borings may be included in the construction contract. This allows the successful bidder for the contract to take these additional borings without interference, since the project site must be cleared of all structures prior to commencing construction.

The additional borings shall be examined in the Bridge Section to determine if any changes will be required in the design of the foundations. The estimated lineal footage of the borings and their cost shall be included in the Engineer's estimate. The location of these additional borings shall be shown on the contract plans. It should be noted, however, that every possible effort should be made to obtain the required substructure information during the design stage.

1.2.8 Presentation of Sub-surface Exploration Data

All borings, test pits, or seismic information that have been taken must appear on the plans, even though some of the borings may be exploratory. This is true even though some of the borings are taken for one site and later the line is changed so that new borings are required. It is mandatory that borings for both lines be shown on the plans.

The exact logs, as specified in the boring contract, must be shown on the plans. If the logs are transcribed on plan sheets, the transcriptions must copy all information exactly as it appears on the logs, including any abbreviations and mis-spellings. It is not necessary to show the blow count for driving the casing. Data relative to core recovery shall be shown on the boring log. It is the responsibility of the boring contractor to accurately describe the soils obtained with the sampler. In printing the description of soils, abbreviations shall be avoided.

The elevations of ground water level at the completion of the boring, unless otherwise specified on the log, shall be shown on the boring log. This elevation may be of great importance in order to determine water control measures for constructing the footing in the dry.

The bottom (top if on ledge) of the proposed footing of each element of the substructure shall be plotted adjacent to the appropriate boring log. Borings shall be plotted in groups as they apply to substructure units for ready reference. In the case of a trestle, the bottom of each pile cap shall be shown on the boring logs.

Boring results shall be plotted to true relative elevation to a scale of not less than 1:100. Deep borings may offset or show discontinuity only in the event that they cannot be completed in one column.

When posting boring logs on the plans the Design Engineer shall post both depth and elevation at each change in strata.

1.3 HYDROLOGY AND HYDRAULICS

1.3.1 Introduction

The purpose of this section is to provide guidance regarding the performance of hydraulic studies for MHD bridges. These studies are required under the Federal Aid Policy Guide, 23 CFR 650A and the American Association of State Highway and Transportation Officials (AASHTO) *Standard Specifications for Highway Bridges*, Article 1.3.2. The detail of hydraulic studies should be commensurate with the significance of the structure to the transportation network and with the risks associated with its failure. The guidelines contained herein are not intended to address all contingencies associated with the hydraulic design of bridge structures. In atypical situations, early consultation with the MHD Hydraulic Engineer is recommended.

1.3.2 Hydraulic Design Criteria

Hydraulic design criteria to be used for MHD bridges are enumerated below. These criteria are consistent with the AASHTO *Hydraulic Design Guidelines*. These criteria are subject to change when conditions so dictate as approved by the Department.

1. To the extent practicable, the proposed facility shall not cause any significant change in the existing flow regime over the range of discharges considered. At sites covered by the National Flood Insurance Program (NFIP), conformance with Federal Emergency Management Agency (FEMA) regulations and regional policy is required.

2. To the extent practicable, pier spacing and orientation, and abutments shall be designed to minimize flow disruption and potential scour.

3. Bridge foundation scour shall be evaluated considering the magnitude of flood, through the 500 year return frequency event, that generates the maximum scour depth.

4. Where practicable, a minimum of 600 millimeters shall be provided between the design approach water surface elevation and the low chord of the bridge for the final design alternative to allow for the passage of debris and ice. Where this is not practicable, the clearance should be established by the Design Engineer based on the type of stream and level of protection desired as approved by the MHD. For navigational channels, a vertical clearance conforming to Federal requirements should be established based on normally expected flows during the navigation season.

5. The proposed facility shall have minimal disruption of ecosystems and values unique to the flood plain and stream.

6. Design choices should support costs for construction, maintenance and operation, including probable repair and reconstruction and potential liability, that are affordable.

1.3.3 Hydraulic Study Procedure

1.3.3.1 Although each individual crossing site is unique, the following procedure should be applied to MHD bridges unless indicated otherwise by the Department.

1.3.3.2 Data Collection. The purpose of this phase is to gather all necessary information regarding the crossing site. The effort expended should be commensurate with the significance and complexity of the project. The following categories of information should be considered.

1. Historic

    1. Topographic/photogrammetric maps.
    2. Surfical/subsurface Geologic maps.
    3. Documented highwater marks.
    4. Anecdotal or documented history of debris accumulation, ice, and scour.

5. Maintenance/inspection records of existing structures (consult MHD or Town Maintenance officials as well as MHD Bridge Inspection database).
6. Aerial photographs (consult MHD survey).
7. Rainfall and stream gage records.

2. Field Survey

    1. Topographical/bathymetric including channel profiles, cross sections, spot soundings, waterway opening geometry.
    2. Tidal monitoring (if applicable).

3. Studies by MHD and other agencies

    1. Federal Flood Insurance Studies (FIS).
    2. Federal Flood Control Studies by the U.S. Army Corps of Engineers (USACOE) and Soil Conservation Service (SCS).
    3. State and Local Flood Plain Studies.
    4. MHD hydraulic studies of existing adjacent or hydraulically similar bridges.
    5. National Oceanic and Atmospheric Administration (NOAA) National Ocean Service database.
    6. United States Geological Survey (USGS) National Water Data Exchange (NAWDEX), Hydrologic Data Reports, Hydrologic Investigation Atlases.

4. Influences on Hydraulic Performance of Site

    1. Other streams, reservoirs, water intakes.
    2. Structures upstream or downstream.
    3. Natural features of stream and flood plain.
    4. Channel modifications upstream or downstream.
    5. Flood plain encroachments.
    6. Sediment types and bed forms.
    7. Storm surge (if applicable).
    8. Daily tidal cycle (if applicable).

5. Environmental Impact

    1. Existing bed or bank instability.
    2. Flood plain land use and flow distribution.
    3. Environmentally sensitive areas (fisheries, wetlands, endangered species habitat).
    4. Hazardous materials.
    5. Land use and culture in the vicinity of the project site.
    6. Recreational/Navigational use.

1.3.3.3 Hydrologic Analysis.

1. Watershed Morphological Considerations

   1. Drainage area.
   2. Watershed and stream slope.
   3. Channel geometry.
   4. Degree of urbanization/regulation.
   5. Soil/vegetation cover.
   6. Natural/built flood storage areas.
   7. Natural/built flow controls.

2. Hydrologic Computations. Recommended methods include:

   1. United States Geologic Survey (USGS) Open Report 80-676 (Reference 22).
   2. Soil Conservation Service's (SCS) Technical Releases 20 and 55 (References 14 and 15).
   3. United States Army Corps of Engineers (USACOE) HEC-1 (Reference 19).
   4. Log Pearson III Flood Frequency Analysis at sites on gaged waterbodies (Reference 21).

   Other standard engineering methods may be used subject to approval by the MHD Hydraulic Section.

3. In general, results from several methods should be compared (not averaged) so as to identify the discharges which best reflect local project conditions with the reasons documented. Further, to establish the existing flow regime at the crossing site, it will be necessary to estimate at least the 10, 50, 100, and 500 return frequency discharge peaks.

4. Design Frequency. The design frequency is the recurrence interval of the flood for which the bridge structure is sized to assure that no traffic interruption or significant damage will result. The overtopping flood and the design frequency flood may vary widely depending on the grade, alignment and classification of the road and the characteristics of the water course and floodplain. See Subsection 1.3.4, *Design Flood or Storm Selection Guidelines*.

5. At sites within a Regulatory Floodway, discharges from the associated Flood Insurance Study (FIS) should be evaluated and adopted if judged reasonable by the Design Engineer. If the FIS flows are determined to be unreasonable and new flow estimates are developed, coordination with FEMA officials will be required.

6. In the case of tidal crossings, the influence of the tide on flow regime shall be considered. Because many tidal bridges are influenced by freshwater as well as tidal flows, the return frequency of the design event is not well defined. The joint probability of riverine floods occurring simultaneously with storm tides, high tides, low tides, and maximum flood and ebb flows must be assessed to determine the magnitude and return frequency of the design event.

1.3.3.4 Hydraulic Analysis.

1. Computer Modelling. A crossing site is subject to either free-surface flow or pressure flow through one or more bridge openings with possible embankment overtopping. It is

impractical to perform the hydraulic analysis for a bridge by manual calculations due to the interactive and complex nature of those computations. These hydraulic complexities should be analyzed using water surface profile computer programs such as FHWA's WSPRO (Reference 6) or USACOE HEC-2 (Reference 16) unless indicated otherwise by the MHD.

2. Hydraulic performance for existing and proposed conditions under at least the 10, 50, 100 discharge peaks should be evaluated for all alternatives considered in the hydraulic study.

3. If a bridge site is located on a waterway reach designated as a regulatory floodway within the NFIP, then the hydraulic model of existing conditions must be calibrated against the waterway's flood profile as illustrated in the associated (FIS).

4. At tidal crossing sites, the time dependent correlation between tide stage, discharge, and velocity must be evaluated. The detail of analysis should be commensurate with the significance of the structure and the complexity of site hydrodynamics. In general the use of one dimensional dynamic computer models such as ACOE's DYNLET1 (Reference 17) is recommended. However, large and complicated tidal bridge projects may warrant assembly and calibration of a two dimensional finite element model (References 5 and 18). Early consultation with the MHD Hydraulic Section to determine an appropriate level of project specific hydrodynamic analysis is recommended.

1.3.3.5 Scour/Stability Analysis.

1. Reasonable and prudent hydraulic analysis of a bridge design requires that an assessment be made of the proposed bridge's vulnerability to undermining due to potential scour. Scour assessment should be consistent with the guidelines set forth in the FHWA's Hydraulic Engineering Circular No. 18 (HEC-18), "Evaluating Scour At Bridges".(Reference 10) and HEC-20, "Stream Stability at Highway Structures" (Reference 11) All alternatives considered should be assessed for scour potential.

2. Even where there are relief structures on the flood plain or overtopping occurs, some flood other than the 500 year flood or "super flood" may cause the worse case bridge opening scour. This situation occurs where the bridge opening will pass the greatest discharge just prior to incurring a discharge relief from overtopping or a flood plain relief opening. Conversely, care must be exercised in that a discharge relief at the bridge due to overtopping or relief openings may not result in reduction in the bridge opening discharge. Should a reduction occur, the incipient overtopping flood or the overtopping flood corresponding to the 500 year flood or "super flood" would be used to evaluate the bridge scour.

1.3.4 Design Flood Or Storm Selection Guidelines

Inundation of the travelway dictates the level of traffic service provided by the facility. The travelway overtopping flood level identifies the limit of serviceability. Table 1.1 below relates desired minimum levels of protection from travelway inundation to functional classifications of roadways. The Design Engineer shall note that Federal law requires interstate highways to be provided with protection from the 2% flood event.

TABLE 1.1 DESIGN STORM SELECTION GUIDELINES

Roadway Classification	Exceedence Probability	Return Period
Rural Principal Arterial	2%	50 year
Rural Minor Arterial	4% - 2%	25 - 50 year
Rural Collector, Major	4%	25 year
Rural Collector, Minor	10%	10 year
Rural Local Road	20% - 10%	5 - 10 year
Urban Principal Arterial	4% - 2%	25 - 50 year
Urban Minor Arterial Street	4%	25 year
Urban Collector Street	10%	10 year
Urban Local Street	20% - 10%	5 - 10 year

1.3.5 References

1. AASHTO, Volume VII-Highway Drainage Guidelines, *Hydraulic Analyses for the Location and Design of Bridges*, AASHTO Task Force on Hydrology and Hydraulics, 1982.

2. AASHTO, *Model Drainage Manual*, 1992.

3. AASHTO, *Standard Specifications For Highway Bridges*, 15th Edition.

4. FHWA, *Highways in the River Environment-Hydraulic and Environmental Design Considerations*, Training and Design Manual, 1975.

5. FHWA, *Finite Element Surface Water Modeling System: Two Dimensional Flow in a Horizontal Plane*, User's Manual, FHWA-RD- 88-177, 1989.

6. FHWA, *Bridge Waterways Analysis Model (WSPRO)*, FHWA-IP-89-027, 1990.

7. FHWA, *Design of Rip Rap Revetment*, HEC-11.

8. FHWA, *Drainage of Highway Pavements*, HEC-12, 1984.

9. FHWA, *The Design of Encroachments on Floodplains Using Risk Analysis*, HEC-17, 1980.

10. FHWA, *Scour at Bridges*, HEC-18, 1993.

11. FHWA, *Stream Stability at Highway Structures*, HEC-20, 1991.

12. FHWA, *Hydraulics of Bridge Waterway Openings*, HDS-1, 1978.

13. FHWA, *Hydraulic Design of Culverts*, HDS-5, 1985.

14. SCS, *Computer Program for Project Formulation Hydrology*, Technical Release No.20 (TR-20), 1983.

15. SCS, *Urban Hydrology for Small Watersheds*, Technical Release No.55 (TR-55), 1986.

16. USACOE, *HEC-2 Water Surface Profiles*, User's Manual, 1983.

17. USACOE, *Dynlet-1: Dynamic Implicit Numerical Model of One-Dimensional Tidal Flow through Inlets*, Technical Report CERC-91-10, 1991.

18. USACOE, *Users Manual for the Generalized Computer Program System: Open Channel Flow and Sedimentation, TABS-2, Main Text and Appendices A through O*, Instructional Report HL-85-1, 1985.

19. USACOE, *Flood Hydrograph Package User's Manual*, HEC-1, 1990.

20. USACOE, *Accuracy of Computed Water Surface Profiles*, December, 1986.

21. USGS, *Guidelines for Determining Flood Flow Frequency*, Bulletin 17B, 1982.

22. USGS, *Estimating Peak Discharges of Small Rural Streams in Massachusetts*, Open File Report 80-676, 1982.

CHAPTER 2
BRIDGE TYPE SELECTION

2.1 BRIDGE TYPES

2.1.1 General

The evaluation of bridge structure type shall consider cost, constructability, historic issues, aesthetics, safety, right of way and environmental impacts. The cost factors shall balance initial economy of the overall project as well as future maintenance. The structures evaluated shall consider all superstructure and substructure options that are relevant for the site. Superstructure cost increases may be offset by substructure cost decreases even to the extent of the inclusion of additional piers to allow set back abutments.

The Design Engineer shall endeavor to arrive at the most serviceable structure while optimizing sight distance, design speed and clearance criteria at the proposed structure site. It is the general policy of the Department and the Federal Highway Administration to design structures of deck type construction. During the preliminary studies it is highly important that the type of structure be approved before final profiles are set since the depth of the superstructure could greatly influence the profile.

Many structures are now constructed at or adjacent to existing structures. Where substructures are in a suitable condition for re-use or can be rehabilitated to a serviceable condition, the merits and cost of re-using the existing substructure shall be considered. If the existing substructure is not deemed serviceable for support of a new superstructure, the merits of saving it as an earth retaining structure should be considered.

Where the bridge structure is historic, found in a historic area or in sensitive wetlands the substructure may be retained without being incorporated into the new structure to minimize the impacts to these resources. The replacement bridge structure may be supported with piles driven behind and or adjacent to the existing structures.

When the impacts from the proposed structure fall under several regulatory jurisdictions, additional copies of the type study report should be submitted to permit concurrent review and initiation of required action by the Department.

In selecting the type of structure, the following items should be considered:

1. Open the bridge to maximum extent for sight distance.

2. Consider possible future widenings of the roadway under the bridge.

3. Provide a structure requiring minimum future maintenance.

4. Wherever possible, eliminate roadway joints in the bridge deck.

5. Minimize environmental impacts.

6. Minimize water control during construction.

7. Eliminate elements in the substructure that are a hazard to traffic.

8. Provide a type of structure that is both functional and architecturally aesthetic.

9. Provide for placement of utilities in the superstructure.

10. For bridges with sidewalks, consideration will be given for adequate and safe access for persons with disabilities on both the bridge and its approaches.

11. Provide the required horizontal and vertical clearances in accordance with the appropriate drawings in the Highway Design Manual and in Part II of the Bridge Manual.

Continuous span design should be used when foundation conditions warrant and the span ratios are satisfactory.

2.1.2 Highway Over Highway

The superstructure may be of steel, prestressed concrete, or reinforced concrete design. Consistent with the vertical clearance, the spans are made as long as possible, keeping the number of piers to a minimum, so as to open up the underpass to the maximum degree.

In the interest of safety, mid-slope abutments should be used and shoulder piers should be eliminated.

2.1.3 Highway Over Waterway

Where clearance conditions warrant its use, long spans are used to open up the waterway from obstructions and to keep the substructure construction in the dry. Chapter 91 of the Massachusetts General Laws, Sections 14 and 23, requires a legislative Act by the General Court for the Construction of a bridge without a draw span over a tidal river, cove, or inlet, except when a fixed bridge, dam, or other structure is in existence downstream of the proposed bridge. Navigational requirements shall be adhered to, according to the rules and regulations of the United States Coast Guard.

For permit requirements, see Paragraph 2.5.4.3, *Related Approvals*.

For hydraulic requirements, see Paragraph 2.5.3.2, Hydraulic Data

When the hydraulic opening has been determined, the use of culverts should be considered. For Interstate Highway design, steel pipe or steel arch culverts are used only in special cases.

2.1.4 Railroad Over Highway

All structures shall be ballasted deck type construction.

2.1.5 Highway Over Railroad

Consideration should be given to use or not use sheeting to protect the track. Consideration should also be given to the possibility of a future lowering of the tracks. Common sense and economics should govern this option.

2.1.6 Pedestrian Overpasses

Consideration should be given to aesthetics, ramps for handicapped persons, hand railings, and protective screen. The maximum ramp slope shall be 8 percent. The minimum width of passageway shall be 2.5 meters between railings. Design criteria should be the latest AASHTO Specifications as modified by Volume V, *Typical Pedestrian Bridges*, Appendix A, Bureau of Public Roads, October 1964.

2.2 TYPE STUDY REPORT

The type study report shall be prepared in a clear and concise manner and shall conform to the standards of subject matter as discussed above. The report shall conform to the outline below in order to ensure that all relevant topics are discussed so that review comments can be kept to a minimum. It is preferred that all topics referenced in the outline be presented and discussed. Where these topics do not apply, they should still be addressed by providing a notation of "not applicable" next to the heading with an appropriate supporting statement.

It is preferred that all required sketched be received in an A4 format with an A3 foldout utilized only when necessary. The sketches should be as specific to the issues discussed in the type study report as possible and extraneous details appropriate to highway layout, utility plans, etc. should not be submitted.

The Type Study Report should include the following:

1. PROJECT LOCUS.

2. EVALUATION OF EXISTING STRUCTURE AND HIGHWAY APPROACHES.

   2.1 Vertical and horizontal alignment of the roadway on the structure and the roadway under the structure.
   2.2 Cross-section for both roadways, including the number of lanes, width of shoulders and provisions for sidewalks.

3. DESCRIPTION OF PROPOSED CONSTRUCTION.

   3.1 Vertical and horizontal clearances.

3.2 Design loading for the structure
3.3 Railing/barrier performance level evaluation.

4. FOUNDATION CONSIDERATIONS

4.1 General subsurface conditions (if available).
4.2 Consideration of various foundation types.
4.3 Cost comparison.

5. TRAFFIC CONSIDERATIONS.

5.1 Safety requirements for the crossing.
5.2 Detours.
5.3 Traffic management plans for stage construction.

6. UTILITIES INVOLVED.

6.1 Location and nature of the existing and proposed utilities.

7. HYDRAULICS (if applicable).

7.1 The Design Engineer shall make sufficient investigation to establish the necessary controls for the design of the waterway opening.

8. COMPARATIVE SUMMARY OF ALTERNATE DESIGNS.

This will include both a cost comparison as well as a discussion of the positive and negative features of the types considered. The cost comparisons shall be complete with checked calculations included in the report and shall include the overall cost of the project.

9. PLAN, PROFILE, ELEVATION, AND CROSS-SECTION OF EACH ALTERNATE.

10. TYPICAL APPROACH SECTION.

11. BACK-UP DATA FOR QUANTITIES AND SOURCE OF UNIT PRICES.

12. CONCLUSIONS AND RECOMMENDATIONS

After all above information is evaluated, the Design Engineer shall make final recommendations to the Department.

2.3 GEOTECHNICAL REPORT

2.3.1 General

The Geotechnical Report is basic document used to present the subsurface site conditions and make design and construction recommendations for all foundation and earthwork aspects of a bridge project.

Four (4) copies of the report the shall be submitted to the Bridge Engineer. Each copy shall be clearly labeled, dated and bound containing all text, graphic presentations, calculations, test data and special specifications. The report shall not be protected by copyright and shall be signed by the Engineer preparing it.

The text of the report shall be concise and as definite as possible, it shall be based upon careful analysis of subsurface data and sound engineering judgement. Extraneous data or discussions should not be included. All recommendations, calculations and analyses shall be consistent with the requirements of AASHTO. All laboratory or in-situ tests conducted on rock, soil or water shall be conducted in accordance with the applicable standards of ASTM.

All geotechnical design properties, engineering values, calculations, data, and equations shall be presented using SI units consistent with the following guidelines:

Parameter or Property	SI units
Deformation, Settlement	(mm)
Force	(kN)
Pressure, Stress, Strength	(kPa)
Modulus	(MPa)
Subgrade Reaction Modulus	(kN/m^3)
Density, ρ	(T/m^3)
Unit Weight, γ	(kN/m^3)
Particle Diameter, d	(μm or mm)
Coefficient of Permeability, k	(m/s)
Coefficient of Consolidation, c_v	(m^2/s)

1. Location plans for borings and subsurface exploration program shall be to metric scales. Boring Logs and soil profiles shall show depth in meters.

2. The Standard Penetration Test (SPT) N values shall be stated on the plans in blows per 300 mm. Description of boring equipment (i.e. spoon sampler, hammer mass and fall height, etc.) shall be in SI units.

3. Pile capacity values shall be in kN. Use soft conversion of current pile dimensions and properties except where established hard values exist.

2.3.2 Report Outline

The report content shall include the following geotechnical elements applicable to the particular project:

1. EXECUTIVE SUMMARY

2. INTRODUCTION

   2.1 Scope of report.
   2.2 Subject background, proposed construction, history.
   2.3 Site reconnaissance and overall description.

3. SUBSURFACE CONDITIONS

   3.1 Local geology: bedrock, surficial and miscellaneous.
   3.2 Subsurface exploration program.
      a) Available subsurface information.
      b) Borings/Soil and Rock samples review.
      c) Probes/Test pits/Observation Wells.
      d) Geophysical investigations.
      e) Soils testing, Laboratory and/or In-situ.

   3.3 Verification of sample descriptions on boring logs.
      a) Statement that all soil and rock samples were visually and manually examined by the Engineer preparing the geotechnical report.
      b) Location and date of sample examination.
      c) Discrepancies or concurrence with boring logs.

   3.4 Subsurface profile.
      a) Written description, characteristics and classification of all soils and rock.
      b) Graphic presentation showing all strata and water conditions as in 6.1.c.
      c) Applicable design parameters for soil and rock: unit weight, gradation, strength, compressibility, moduli, rockmass rating, and jointing.

   3.5 Seismic design parameters, liquefaction potential.

4. RECOMMENDED FOUNDATION SYSTEM

   4.1 Retain or modify existing foundation.
      a) Existing foundations/substructure depth, configuration, integrity and bearing material. The Design Engineer shall design and conduct the appropriate method of investigation.
      b) Applicable design study (see 4.2, 4.3 or 4.4.)

   4.2 Embankment considerations (primarily for weak subsoils.)
      a) Stability - excavation/replacement, stage construction, berms, flattened slopes, lightweight fill, subsoil soil modification, fill reinforcement, erosion control.
      b) Settlement - magnitude, primary, secondary, subsoil modification, waiting periods, surcharges, lateral movements, down-drag on piles.

4.3 Shallow foundation design.
  a) Rational supporting shallow foundation selection (qualifying reasons, site and cost factors.)
  b) Bottom of footing elevation selection.
  c) Ultimate and allowable soil bearing capacity.
  d) Estimate of total settlement, differential settlement and lateral movements.
  e) Parameters for internal and external stability and design of abutments, walls and earth support systems.
  f) Global stability (substructure-slope-subsoil system.)
  g) Subsoil preparation, fill material and compaction, soil/rock removal, treatment or stabilization.
  h) Scour protection.
  i) Special considerations.

4.4 Deep foundation design.
  a) Rational supporting deep foundation system.
  b) Recommended type (qualifying reasons, site and cost factors.)
  c) Ultimate and allowable axial capacity - static analysis, factor of safety selection, stress wave analysis (piles), actual driving resistance vs. design resistance (scour), load tests.
  d) Lateral load analysis.
  e) Estimated lengths, depths and tip elevations.
  f) Group design - group size, capacity, configuration, settlement.
  h) Drilled shaft design - diameter, socket length, settlement.
  i) Construction considerations - likely method of construction, pile driving criteria and procedures, negative skin friction, vibrations, predrilling, obstructions.
  j) Special considerations - corrosion, coatings.
  k) Other methods - pressure injected footings, jet grouting, jacked piles.

5. CONSTRUCTION CONSIDERATIONS

5.1 Water table - fluctuations, artesian conditions, effects of drawdown, pumping.
5.2 Recommended method for water control and preliminary design thereof.
5.3 Excavations - methods, earth support requirements, rock removal, OSHA requirements.
5.3 Obstructions - nature of, method of removal, break-through and payment.
5.4 Protection of adjacent structures and utilities - excavations, construction loads, settlement, vibrations, pumping.
5.5 Sequence of construction activities - stage construction, surcharging, pile installation.
5.6 Special geotechnical monitoring and instrumentation.

6. APPENDIX

6.1 Graphic Presentations.
  a) Project locus map.
  b) Site Plan showing as drilled boring locations, proposed and existing structures.

- c) Interpreted soil profile with foundation elements.
- d) Design charts and graphs.
- e) In-situ and lab test results.

6.2 Tables and Text.

- a) Tabulated soil design parameters.
- b) Tabulated in-situ and lab test results.
- c) Table of foundation design alternates, criteria and costs.
- d) All calculations performed by hand, spreadsheet or computer program including date performed, initials and references used.
- e) Design charts or tables.
- f) Final approved boring logs.
- g) Applicable special provisions or specifications.
- h) All special notes for plans.
- i) Specific limitations.

2.4 HYDRAULIC REPORT

2.4.1 General

The Hydraulic Report will include a narrative explaining analytical methods used and summarizing results and recommendations. Pertinent information collected, computations, plans, other data should be included in the report's appendices.

Four copies of the report shall be submitted to the Bridge Engineer. Each copy shall be clearly labelled, dated and bound. The report shall not be protected by copyright and shall be signed by the Engineer preparing it. An electronic copy of the document shall also be submitted on an 89 millimeter 1.44 MB flexible disc.

2.4.2 Report Outline

An outline of the standard text plus information to be included in each section is as follows:

1. EXECUTIVE SUMMARY

This section is intended to briefly summarize the results of the study. The following items should be included:

1.1 Identification of alternatives considered.
1.2 Degree to which each alternative can practicably meet design criteria.
1.3 Special environmental, transportation, flood, or considerations affiliated with the crossing site.

2. PROJECT DESCRIPTION

This section is intended to define the site location and the objectives of the study. The following items should be included:

2.1 Bridge Number.
2.2 Highway Number and/or Local Name.
2.3 Functional Classification of roadway, including average daily traffic.
2.4 Bridge description including date of construction, type,present AASHTO sufficiency rating, and the reason for replacement/rehabilitation (if applicable).
2.5 Waterbody/Waterway Name and watershed affiliation.
2.6 Brief description of watershed, including size, land cover, topography, and degree of urbanization.
2.7 Brief description of the waterway at the bridge site, including channel slope, stability, and bed material.
2.8 Land uses in the vicinity of the bridge.
2.9 Brief description of any special transportation environmental, flood, or scour issues associated with the crossing site and how they may effect project design, construction, and maintenance.

3. DATA COLLECTION

This Section will summarize the results of the data collection and evaluation, including the following:

3.1 Agencies contacted and data gathered from each
3.2 Summary of the evaluation of the data collected and explanation of its use in the investigation

4. ENGINEERING METHODS

This section will briefly discuss the computational methods used in the study including:

4.1 Hydrologic Analyses. Discussion of methods used to compute discharge peaks.
4.2 Hydraulic Analyses. Discussion of hydraulic model assembly and calibration methodology.
4.3 Scour/Stability Analyses. Discussion of scour/stability evaluation procedure and any pertinent computation methods.

5. CONCLUSIONS AND RECOMMENDATIONS

This section will present a tabulation of computed and compiled hydrologic and hydraulic data for posting on the bridge sketch plans and the Design Engineer's recommendations for a preferred hydraulic opening alternative with consideration to minimization of:

1. Impact on the existing hydraulic regime.
2. Impact on adjacent ecosystems.
3. Scour/flood damage risk.

6. APPENDICES

    6.1 Crossing Site Catchment (1:25000 USGS Quad).
    6.2 Stream Cross Section Layout Plan.
    6.3 Field Evaluation Forms.
    6.4 Hydrologic Computations.
    6.5 Hydraulic Computations.
    6.6 Scour and/or Scour Counter Measure Computations.
    6.7 Photographs and Index (include a sufficient number of photographs to illustrate the road and waterway approaches to the bridge, the bridge structure, and any adjacent natural or built features that may be affected by the design).

2.5 SKETCH PLANS

2.5.1 Introduction

2.5.1.1 The Bridge Sketch Plan is a preliminary presentation of the overall concept of the proposed structure. It shows all major features to be incorporated into the construction plans.

2.5.1.2 The Design Engineer shall not proceed with the preparation of construction plans until approved sketch plans have been received from the Department. In addition to Department approval the plans may require approval by the Federal Highway Administration (FHWA).

2.5.1.3 Sketch Plans must be provided for all structures which require design. Sketch Plans are not required for structures taken from Department Construction Standards. Exceptions to the above will be made only with the approval of the Bridge Engineer. Before the sketch plans are submitted, the Design Engineer must obtain the Bridge Number and/or B.I.N. (Bridge Identification Number) for each structure from the Bridge Engineer. This request must be made in writing as soon as the Type Study has been accepted.

2.5.2 Data Required for the Preparation of Sketch Plans

1. Borings
2. Hydraulic Data (if applicable)
3. Traffic Data
4. Highway Geometrics
5. Clearances
6. Bridge Type (approved by the Department)
7. Soils Report
8. Design Loading
9. Requirements of Utility Companies
10. Plot Plan (or other documentation used to determine length of walls)

2.5.3 Preparation of Sketch Plans

2.5.3.1 Sketch plans submitted for signature shall be drafted on mylar (plastic drafting film). Sheet sizes, borders and title blocks shall be as detailed on Drawing No. 1.2.1 of Part II of the Bridge Manual. The minimum height of lettering shall be 3 millimeters. The sketch plans shall be organized as follows:

1. First Sheet
2. Boring Sheets
3. Structure Detail Sheets

2.5.3.2 First Sheet. The first sheet of the sketch plans shall contain the following information:

Standard Title Block.

Standard Data Block.

Locus. A small scale plan which serves as a map to locate the structure. Approximate scale is 1:1000.

Key Plan. A plan of the proposed structure, typically drawn to a scale of 1:500, showing baselines, center lines of construction, curve data, roadway widths, angles of intersection to establish geometry of the structure, equation of stations of intersecting baselines, existing and relocated utilities, configuration of proposed and existing structures and their footings, topographical features, and layout lines if available. Where a waterway is involved, show the old location and the proposed location of the stream. Show riprap treatment and any channel paving. The locations of all borings, test pits and/or other subsurface investigations shall be shown on the key plan.

Profiles. A profile of each road, railroad or stream bed shall be shown with proposed and existing ground grades, outline of proposed and existing structures and limits of any preload earth embankments. Typically for most structures, the vertical scale is 1:100 and the horizontal scale is 1:500.

Design Specification. The following note should appear on the first sheet:

> DESIGN
> IN ACCORDANCE WITH THE 19-- AASHTO SPECIFICATIONS WITH INTERIM SPECIFICATIONS THROUGH 19-- FOR MS18 LOADING. *(Use this note for bridges carrying roadways. If the design loading is different from MS18, specify the actual design loading)*

Any design criteria that varies from AASHTO Specifications or the MHD Bridge Manual shall be so noted on the Sketch Plan.

> DESIGN
> IN ACCORDANCE WITH THE 19-- AREA SPECIFICATIONS FOR RAIL BRIDGES, WITH INTERIM SPECIFICATIONS THROUGH 19--. *(Use this note for bridges carrying railroads)*

Notes. The following notes shall appear on the first sheet:

NOTES

1. APPROVAL DOES NOT INCLUDE THE PROFILE GRADES WHICH ARE PRELIMINARY ONLY. *(This note may be omitted if profile has been approved).*
2. APPROVAL DOES NOT INCLUDE STRUCTURAL ANALYSIS. *(Approval does not include structural analysis nor does it relieve the Design Engineer of the responsibility for proposing an economical and buildable structure).*
3. DIMENSIONS OF STRUCTURAL MEMBERS ARE APPROXIMATE, AND WILL BE FINALIZED DURING THE FINAL DESIGN PHASE.
4. SEE GEOTECHNICAL REPORT, DATED *(give date)*.
5. SEE HYDRAULIC REPORT, DATED *(give date)*.
6. NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988 IS USED THROUGHOUT *(if the survey was based on the National Geodetic Vertical Datum (NGVD) of 1929, change the reference in the note accordingly)*.

Hydraulic Data. For any structure over a stream the following data shall be listed on the first sheet:

Hydraulic Data

Drainage Area: ________________ Hectares or Square Kilometers
Design Discharge: ______________ cubic meters per second
Design Frequency: ______________ years
Design Velocity: ________________ meters per second
Design High Water: Elev. ________

Basic Flood Data

Q (100 year): __________________ cubic meters per second
Water Surface Elevation: __________

Flood of Record

Q= ___________________________ cubic meters per second)
Frequency (if known): ___________ yrs.
Date: ___________________________
History of Ice Floes: _____________
Evidence of Scour and Erosion: ____

2.5.3.3 Boring Sheets. The following information should appear on the boring sheets:

Boring Data.

Boring Logs: Boring logs shall be plotted in groups as they relate to substructure units. All boring logs shall be plotted to the same base elevation.

Water Levels: Water level at each boring should be plotted to scale and date of observation should be shown.

Footing Elevations: The elevations at the bottom of each proposed substructure unit should be plotted to scale. The approximate elevation of the pile tips or drilled shaft bottom shall be plotted where appropriate. In the case of a substructure unit founded on ledge, the elevation at the top of the footing shall be plotted.

Boring Notes. The following notes shall appear on the first sheet of the Boring Data sheets of all sketch plans:

BORING NOTES

1. LOCATION OF BORINGS SHOWN ON THE PLAN THUS: *(see Drawing 1.3.3 of Part II for boring symbols).*

2. BORINGS ARE TAKEN FOR PURPOSE OF DESIGN AND SHOW CONDITIONS AT BORING POINTS ONLY, BUT DO NOT NECESSARILY SHOW THE NATURE OF THE MATERIALS TO BE ENCOUNTERED DURING CONSTRUCTION.

3. WATER LEVELS SHOWN ON THE BORING LOGS WERE OBSERVED AT THE TIME OF TAKING BORINGS AND DO NOT NECESSARILY SHOW THE TRUE GROUND WATER LEVEL.

4. FIGURES IN COLUMNS INDICATE NUMBER OF BLOWS REQUIRED TO DRIVE A 50.8 MILLIMETER SPLIT SPOON SAMPLER 300 MILLIMETERS WITH A 63.5 KILOGRAM MASS FALLING 760 MILLIMETERS.

5. BORING SAMPLES MAY BE SEEN AT THE RESEARCH AND MATERIALS DIVISION, 400 D STREET, SOUTH BOSTON, MASSACHUSETTS, 02210-1953.

6. ALL BORINGS WERE MADE IN *(give month(s) and year(s)).*

7. BORINGS WERE MADE BY *(give name and address of boring contractor).*

8. THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988 IS USED THROUGHOUT *(if the survey was based on the National Geodetic Vertical Datum (NGVD) of 1929, change the reference in the note accordingly).*

9. THE DEPTHS AS SHOWN ON THE ORIGINAL BORING LOGS HAVE BEEN CONVERTED TO ELEVATIONS BY THE ENGINEER.

Ground Water. If ground water observation wellpoints have been installed, the observed water levels will be tabulated on the sketch plans along with the following notation:

GROUND WATER

THE WATER LEVELS RECORDED IN THE TABLE ARE THOSE MEASURED ON THE DATES GIVEN AND DO NOT NECESSARILY REPRESENT GROUND-WATER LEVEL AT TIME OF CONSTRUCTION.

2.5.3.4 Structure Detail Sheets. At a minimum, the following information shall be put on the structure detail sheets:

Square Longitudinal Section. The scale is normally 1:100, but it will vary depending upon the length of structure. This is a square section of the structure showing its relationship to the highway, railroad, or stream under the structure. Shown on this view are the following items:

1. All horizontal and vertical clearances (if the proposed structure modifies or replaces an existing structure, show existing and proposed clearances).
2. Elevation at bottom of footings (top of footings if on ledge) or approximate pile tip of bottom of shaft elevation.
3. Location of fixed and expansion bearings.
4. Allowable soil bearing pressures or design and ultimate pile or shaft capacities.
5. Type of pile (if any).
6. Gravel borrow for bridge foundations or crushed stone for bridge foundations (if any).
7. Existing ground.
8. Proposed cross-section of road, railroad, or stream under the structure (give all pertinent dimensions such as sidewalk and roadway widths, track to track centerlines as well as their distances from the proposed or retained substructure elements).
9. Individual span lengths and overall span length, both square and skew, (center line to center line of bearings).
10. Tremie seal and sheeting (if applicable, see Subsection 3.2.3 for guidelines).

Elevation of Pier. A scale view, along the length of the pier, showing critical dimensions to be used in its design.

Transverse Section of Superstructure. A cross-section of the superstructure showing:

1. All critical dimensions
2. Roadway cross-slopes
3. Type of railing or barrier
4. Utility locations
5. Spacing, depth, and type of beam
6. Slab thickness and type
7. Type of surfacing

If stage construction is involved, show the limits of both the existing and proposed structures for all stages of construction. These sections should also show all details and dimensions necessary to determine the adequacy of the proposed staging from both a structural and traffic safety standpoint.

Channel Approach Section. A cross-section of the waterway approaches to the bridge showing:

1. Existing and proposed channel dimensions
2. Treatment of slopes
3. Existing water elevation
4. Design water elevation

Approach Section. A cross-section of the approach to the superstructure showing controlling dimensions and details.

2.5.4 Submission and Approvals

2.5.4.1 Submission of Bridge Sketch Plans. Initial submission of sketch plan prints for review are as follows:

MBTA crossing - 3 sets
Other RR crossing - 6 sets
Waterway crossing - 3 sets
Highway crossing - 3 sets

If project requires FHWA review and approval, a second submission of two sets of prints will be required after all review comments are resolved.

2.5.4.2 Review Process. Plans showing review comments will be returned to the Design Engineer, who will resolve all comments and correct the original tracings as necessary. Corrected tracings and all review prints will be transmitted to the Department where the tracings will be back-checked and given initial approval. The Department shall forward the initially approved sketch plans to FHWA if their approval is required. Should the FHWA comment on the plans, all comments will be resolved and necessary changes will be made to the plans by the Design Engineer.

Final tracings will be forwarded for the approval signatures. Two sets of prints of approved sketch plans will be sent to the Design Engineer and are the basis for the preparation of the design. The final mylars become the property of the Department.

2.5.4.3 Related Approvals. License plans for permits, if applicable, are to be prepared as outlined in the Federal Register. Federal legislation of 1975 requires the filing of applications with both the U.S. Coast Guard and the U.S. Corps of Engineers.

Permit plans, with letters of application, environmental requirements, water pollution control requirements, and other related material as required, will be processed through the Department.

CHAPTER 3
BRIDGE DESIGN GUIDELINES

3.1 DESIGN CRITERIA

3.1.1 Design Specifications

3.1.1.1 All designs for highway bridges shall be performed in accordance with the latest edition of the following specifications and as modified by this Bridge Manual:

1. American Association of State Highway and Transportation Officials (AASHTO), *Standard Specifications for Highway Bridges*.

2. The Commonwealth of Massachusetts, Massachusetts Highway Department, *Standard Specifications for Highways and Bridges*.

3. AASHTO/AWS *Bridge Welding Code* (ANSI/AASHTO/AWS D1.5).

3.1.1.2 All designs for railroad bridges shall be performed in accordance with the latest edition of the American Railway Engineering Association (AREA), *Manual for Railway Engineering*.

3.1.2 Design Methods

Current Bridge Section policy with regards to design methods is as follows:

1. All superstructures of all types shall be designed in accordance with the Service Load Design Method (Allowable Stress Design) of the AASHTO specifications.

2. All substructures shall be designed in accordance with the Strength Design Method (Load Factor Design) of the AASHTO specifications.

3.1.3 Live Load

3.1.3.1 The minimum AASHTO design live load for all bridges, culverts and walls shall be MS18. For structures on Federal Aid Interstate Highways, including structures on connectors between Interstate Highways and Interstate Highway on/off ramps, the minimum loading shall be MS18 modified for Military Loading.

3.1.3.2 Existing bridges that are being rehabilitated will be upgraded to meet the minimum design loading of Paragraph 3.1.3.1.

3.1.3.3 Historic structures that are being rehabilitated may be exempted from complying with Paragraph 3.1.3.2 if the structure's inventory rating can be upgraded to meet the anticipated truck traffic loadings. Any exemptions will be granted only by the Bridge Engineer.

3.1.4 Bridge Railings/Barriers

3.1.4.1 The latest edition of the AASHTO *Guide Specifications for Bridge Rails* will be used to determine the appropriate Performance Level for the bridge railing/barrier for the structure.

3.1.4.2 The railings/barriers detailed in Chapter 9 of Part II of the Bridge Manual shall be used in accordance with the following matrix:

Railing/Barrier	Performance Level	Application Notes
CT-PL1*	PL 1, less than 45 mph	W/ or w/out pedestrians; no protective screen
S3-PL2	PL 2 or less	W/ or w/out pedestrians
CP-PL2	PL 2 or less	W/ or w/out pedestrians, mainly urban & RR bridges and all structures over electrified AMTRAK rail lines; must be used with either Type II screen or hand rail
CF-PL2	PL 2 or less	Bridges with no pedestrian traffic
CF-PL3	PL 3	All Interstate and limited access highway bridges

3.1.5 Other Design Criteria

3.1.5.1 Earth Pressure. Current Department practice is to design earth retaining structures for a minimum equivalent fluid pressure of 5.5 kiloNewtons/cubic meter and a unit weight for earth of 19 kiloNewtons/cubic meter. Earth retaining structures with a sloping backfill or point load surcharges shall be designed in accordance with AASHTO Section 5.

3.1.5.2 Temperature. Thermal stresses and movements shall be calculated in accordance with the AASHTO Specifications for the Cold Climate temperature range.

3.2 FOUNDATION DESIGN

3.2.1 General

The recommendations made in the Geotechnical Report shall form the basis for the selection and design of the foundation of the bridge structure. In addition to recommending the foundation type, this report also provides the site specific design parameters, such as soil bearing pressures, on which the foundation design will be based. Pertinent information from the Geotechnical Report regarding design and/or construction shall be included on the plans and in the special provisions.

3.2.2 Pile Foundations

3.2.2.1 Pile foundations will be designed in accordance with the provisions of the AASHTO Specifications. The following criteria shall be used as required:

1. Maximum batter on any pile shall be 1:3. When cast-in-place concrete piles are driven in clay, the maximum batter shall be 1:4.

2. Vertical or battered piles can be assumed to offer 22 kiloNewtons of lateral resistance per pile, if the foundation material is reasonable. This 22 kiloNewtons is in addition to the lateral resistance provided by the horizontal component of the axial load of the battered pile. The Geotechnical Report may recommend allowables either greater or less than these.

3. Maximum spacing of piles is 3 meters on centers, minimum spacing is 750 millimeters on centers.

4. Minimum distance from edge of footing to center of pile is 500 millimeters.

5. The resultant center of pressure and the center of gravity of the pile layout shall coincide as nearly as practical.

6. Pile layouts of piers with continuous footings shall show a uniform distribution of piles. Exterior piles on the sides and ends of pier footings shall be battered.

7. When steel piles are driven through a cinder or other acidic stratum, that portion of the steel pile remaining in the cinder or other acidic stratum shall be coated with an approved material.

8. When roadway borrow is more than 3 meters in depth, holes should be pre-augured for all piles except H piles.

9. Pile to footing connections shall be designed to transfer no less than 10 % of the pile's ultimate capacity in tension. Weldable reinforcing steel attachments shall be provided on steel piles where necessary to transfer pile tension.

3.2.2.2 Pile Capacities. The design of piles shall be based on the capacities calculated from the following allowables for the type of pile used:

Steel: capacity based on an allowable stress of 62 megaPascals on the gross steel area.

Concrete: Cast-in-place thin shell concrete piles:
350 to 450 kiloNewton capacity based on an allowable stress of 0.33 f'c.

Cast-in-place pipe piles:
capacity based on an allowable stress of 0.4 f'c on the gross area of pile defined by its outside diameter, up to a maximum of 450 kiloNewton capacity. Capacities of cast-in-place pipe piles greater than 450 kiloNewtons shall be verified by pile load tests.

Timber: maximum of 260 kiloNewton capacity. Actual capacity will depend upon species of wood and tip and butt diameters.

3.2.2.3 Depth of Piles.

Steel: Steel Pipe Piles and H Piles can be driven to any reasonable depth. Pipe Piles and H Piles longer than 15 meters shall have a minimum section modulus of 500 000 mm^3 about any axis.

Concrete: Cast-in-place Concrete Thin Shell Piles can be driven to approximately 24 meter depths.

Timber: Piles are locally available to a length of approximately 20 meters.

3.2.3 Sheet Piling Design

3.2.3.1 All sheeting that is to be left in place shall be designated as permanent sheeting shall be fully designed, shown on the plans and a unit price item provided for permanent sheeting in the estimate. All sheeting that is to be left in place shall be steel sheeting. The design shall include the following:

1. Plan view indicating horizontal limits of sheeting.
2. Cross-section indicating vertical limits of sheeting.
3. Minimum section modulus of steel sheeting.
4. Where a braced sheeting design is indicated, the design of the bracing and wales shall also be provided and shown with full dimensions on the plans.

3.2.3.2 The Design Engineer, in designing the sheeting, shall account for the possibility that the bottom of excavation may be lowered by a maximum of 600 millimeters. This lowering may be due to over-excavation or removal of unsuitable materials.

3.2.3.3 Sheeting that is used in conjunction with a tremie seal cofferdam shall be left in place. The depth of the tremie shall be designed by the Design Engineer with a minimum factor of safety of 1.5. The cofferdam shall be designed by the Contractor. The Design Engineer shall indicate the horizontal and vertical limits of the steel sheeting for the cofferdam. In addition the Design Engineer shall indicate on the plans the elevation at which the cofferdam should be flooded in the event that the water rises outside the cofferdam to cause excess hydrostatic pressure.

3.2.3.4 Sheeting that protrudes into the soil that supports the bridge structure shall be left in place. Supporting soil shall be defined as all soil directly below the footing contained within a series of planes that originate at the perimeter of the bottom of the footing and project down and away from the footing at an angle of 45° from the horizontal. Sheeting placed at the heels of abutment and walls may be exempted at the discretion of the Bridge Engineer.

3.2.3.5 All sheeting required for the support of railroads shall be designed as permanent sheeting by the Design Engineer.

3.2.3.6 Whether sheeting is indicated on the plans or not, the Contractor shall be informed by the Special Provisions that any sheeting driven into the supporting soil below the bridge structure, as defined by Paragraph 3.2.3.4, shall be left in place and no payment will be made for this sheeting.

3.2.4 Drilled Shafts

3.2.4.1 Drilled shafts shall be considered where cost and constructability may be favorable compared to spread footing or pile supported structures. Anticipated advantages are the reduction of the quantities and cost of excavation, dewatering, and sheeting. Additionally, the use of drilled shafts may be beneficial in working within critical horizontal restrictions, or in limiting the environmental impact.

3.2.4.2 Design. Drilled shafts shall be designed in accordance with the requirements of the latest AASHTO specifications and the following:

1. The Design Engineer shall consider the intended method of construction and the resulting impact on the stiffness of the shaft. If the pier column is an integral extension of the drilled shaft and the design assumes a constant diameter throughout, it is imperative that either the construction of the shaft shall be consistent with this assumption or that the revised details be fully evaluated prior to construction.

2. The design point of fixity of the drilled shaft shall be determined using soil-pile interaction computer solutions or other acceptable methods. When a drilled shaft is constructed with a permanent casing, the skin friction could be significantly reduced. The Design Engineer needs to make some judgement about the loss of axial capacity that results from the unintentional leaving of the casing in place or the intentional use of permanent casing.

3. Continuous steel reinforcing shall be maintained where possible throughout the length of the shaft. Splices should be avoided in the longitudinal steel where practical. If splices are unavoidable, they shall be made with a mechanical connector and shall be staggered a minimum of 600 millimeters. Splices in the spiral confinement reinforcement shall, where necessary, be made using mechanical connectors. Detailing for seismic requirements prohibits splices in those regions which may develop plastic hinges. The Design Engineer shall ensure that cover requirements are met over the mechanical connectors.

4. The maximum aggregate size shall be 20 millimeters. Concrete mix design and workability shall be consistent for tremie or pump placement.

5. Construction drawings shall be fully consistent with construction assumptions used in the design phase.

3.2.4.3 Special design and detailing is required where the drilled shaft is an extension of a pier column. The drilled shaft reinforcement shall be continuous with that of the pier column. The spiral reinforcing shall extend from the base of the shaft into the pier cap as required by the AASHTO seismic requirements.

3.2.4.4 The pier column and drilled shaft may be cast monolithically. The concrete placed for the pier columns shall be a high slump (100 mm minimum slump) 30 MPa - 20 mm - 390 kg Cement Concrete Masonry. If the pier column is within the traffic splash zone, or is in a river stream, the concrete shall be a silica fume modified concrete mix.

3.2.4.5 Estimation of Quantities. Quantities for the drilled shaft item shall be estimated per cubic meter of excavated material. The work under this will include all equipment required to the complete installation of the caisson; the water control; the excavation, auguring, coring or drilling of the shaft; dewatering of the shaft; and the placement of the steel reinforcement cage. Concrete for the drilled shaft and integral pier column shall be compensated for under the relevant concrete item. Excavation of obstructions and or coring for a rock socket shall be separate unit price cost items.

3.2.4.6 Construction. The Special Provisions for this item shall reflect the following conditions:

1. Work done under the Drilled Shaft item shall conform to the applicable provisions of Section 901 and Section 940 of the Massachusetts *Standard Specifications for Highways and Bridges*, and Section 5, *Drilled Piles and Shafts*, Division II, Construction, of the AASHTO *Standard Specifications for Highway Bridges*.

2. The drilled shafts should preferably be constructed in the dry. The casing and wet method of construction shall be employed where applicable as determined by the soil conditions.

3. Drilled Shaft construction shall be maintained at the highest practical tolerances for the proposed site. The excavation for a drilled shaft should be made so that the axis of the shaft is within 1/24th of the shaft diameter or 75 mm from its plan location which ever is less. In addition the shaft should be within 2% of plumb for the total length of shaft. Plumbness shall be measured from the constructed position of the top of the excavation. The top of shaft elevation should be no more than 25 mm above or 75 mm below the plan elevation.

4. During the concrete pour, the reinforcing cage should be held in position by some positive method to minimize displacement. The cage shall be designed to be stable under erection loads. Additionally, the cage must maintain stability during the concrete placement and the withdrawal of the temporary casing. The reinforcing cage shall be placed, centered and braced to insure that proper location is maintained throughout the placement of concrete and curing.

5. The drilled shaft shall be placed at a minimum to a depth as specified on the plans. Typically it is expected that drilled shaft shall be anchored in sound bedrock. Shafts which are short in length may require rock socketing to provide adequate lateral load carrying capacity.

6. The proposed construction method should be submitted to the Engineer for approval.

3.2.5 Gravel Borrow for Bridge Foundations

3.2.5.1 The maximum allowable bearing capacity on **GRAVEL BORROW FOR BRIDGE FOUNDATIONS** (Item 151.1) shall be 190 kiloPascals. Gravel for this item will be permitted up to a height of 6 meters under the footings and shall be compacted in accordance with the Massachusetts *Standard Specifications for Highways and Bridges*. In special cases, this depth may be increased. A study should be made in each case to show that its use will effect an economy in the cost of the structure. Its use is not authorized for river structures or for placement under water.

3.2.5.2 **GRAVEL BORROW FOR BRIDGE FOUNDATIONS** with an allowable bearing capacity of 290 kiloPascals may be used if prior approval is given by the Bridge Engineer and only if a special provision for placing borrow with this capacity is included in the Contract Documents.

3.2.6 Crushed Stone for Bridge Foundations

In general, this material is used where water conditions prevent the use of **GRAVEL BORROW FOR BRIDGE FOUNDATIONS**. The pressure on the granular soil below the crushed stone will govern the allowable load on the crushed stone. De-watering the area and using **GRAVEL BORROW FOR BRIDGE FOUNDATIONS** compacted in the dry, or not de-watering and using **CRUSHED STONE FOR BRIDGE FOUNDATIONS** shall be investigated for feasibility and economy.

3.2.7 Foundations on Ledge

3.2.7.1 If the top of ledge is comparatively level and is located at a shallow depth from the proposed bottom of footing, then, for economy, consideration shall be given to lowering the footing so that it will be founded entirely on ledge.

3.2.7.2 If a footing will be located partly on ledge and partly on satisfactory granular material, the ledge should be excavated to a depth of about 500 millimeters below the bottom of footing and backfilled with **GRAVEL BORROW FOR BRIDGE FOUNDATIONS**. Consideration should also be given to excavating the material above the ledge and backfilling with 20 MPa - 40 mm - 280 kg Concrete Masonry to the bottom of proposed footing elevation. In either case, the footing must be founded on the same material throughout its bearing length.

3.2.7.3 All deteriorated ledge shall be removed so that the entire footing will rest on sound rock.

3.2.8 Pre-loaded Areas

3.2.8.1 Pre-loading may be required to consolidate compressible soils under a bridge site which, although adequate from a bearing capacity standpoint, are subject to large long-term settlements under load. If unsuitable material is encountered, it shall be excavated prior to placing the embankment. Often this pre-load is surcharged to hasten consolidation and the structure built under another contract, founded on the materials that have been placed in the first contract.

3.2.8.2 If the water table is higher than the bottom of excavation of unsuitable material, crushed stone will be used in the embankment up to the proposed elevation of the bottom footing. Both of these materials are placed during embankment construction. The amount of anticipated settlement should be accounted for in specified top elevation of the special material beneath the proposed bottom of footing.

3.3 SUBSTRUCTURE DESIGN

3.3.1 General

3.3.1.1 Abutments and walls shall be proportioned in accordance with the standard details shown in Part II of the Bridge Manual and shall be designed for service loads with a factor of safety of 2.0 against overturning and a factor of safety of 1.5 against sliding. The passive resistance of the earth in front of a wall shall be neglected in determining wall stability. The stability of the wall during all stages of construction shall be investigated. If sliding is indicated in the analysis, then a reinforced concrete key tied into the footing shall be designed to aid in the resistance to sliding.

3.3.1.2 Maximum pressures under the footings shall be calculated in accordance with AASHTO. The weight of the earth in front of a wall shall be considered in computing soil pressure. The resultant center of pressure shall be located within the middle third of the bottom of the footing when it is founded on suitable material. When a wall is founded on ledge, the resultant center of pressure may come within the middle half of the footing.

3.3.1.3 The non-seismic longitudinal forces for abutment design shall include:

1. The live load longitudinal forces specified in AASHTO Section 3.
2. The horizontal shear force developed by the bearings through either shear deformation (elastomeric bearings) or friction (sliding plate bearings).

3.3.1.4 Piers and abutments of a bridge over salt water will normally be protected with granite within the tidal range. The granite blocks will be caulked with polysulfide caulking. Piers and abutments over fresh water do not require this protection unless the normal flow of water and seasonal water level variations are anticipated to be large.

3.3.1.5 At a minimum, the reinforcing bars used in the following elements of the substructure require protection and, so, shall be epoxy coated: backwalls, beam seats, piercaps, and the Silica Fume Modified concrete pour section of U-wingwalls. Also, when abutment faces, piers, and wingwall faces are within 10 meters of a traveled way, the reinforcing bars adjacent to those faces shall be epoxy coated. If all of the reinforcing bars in the given concrete pour are to be coated, and the coated bars will never come into contact or be tied to non-coated bars, then galvanized bars may be used instead of epoxy coated bars. In these situations, the plans shall designate these bars as COATED BARS, without specifying the coating.

3.3.2 Walls: Abutment and Wingwall

3.3.2.1 Gravity walls. Walls of this type are used where low walls are required, generally up to 4 meters in height.

When the wall is founded on sound ledge the footing is omitted. The resultant center of pressure shall come within the middle half of the base of the wall. Tension under the back of the wall shall not exceed 340 kiloPascals. The top of ledge shall be roughened as necessary to provide resistance against sliding. A shear key may be provided, if necessary.

3.3.2.2 Cantilever walls. Generally, this wall type is used in the intermediate height range applications between gravity and counterfort walls. In those situations where a wall starts in the height range prescribed for cantilevered walls but tapers down into the height range prescribed for gravity walls, the cantilevered wall type will be used throughout instead of changing to a gravity type in mid-wall.

When designing the reinforcing in the toe of the footing, the weight of the soil above the toe shall not be used to offset the force of the upward soil pressure. The reinforcing in the heel of the footing shall be designed to carry the entire superimposed dead load, including the dead load of the heel. The effect of the upward soil pressure or pile reaction will not be used to offset this design load.

3.3.3 Counterfort Walls

A counterfort wall design shall be considered for retaining structures and abutments higher than 9 meters. However, the economics and constructability of a counterfort wall versus a similar height cantilevered wall with a thicker stem shall be investigated.

3.3.4 Piers

3.3.4.1 Piers for most structures are typically of reinforced concrete construction. Piers for grade separation structures are typically open type bents with circular columns. Piers for structures over railroads can be either a solid stem type or an open type bent with a crash wall conforming to AREA requirements for pier protection, depending on an economic analysis. Piers for structures over water are typically a solid stem type. Piers for trestle type structures are typically pile bents.

3.3.4.2 For open type bents, the bottom of the pier cap is normally level and the same cross-section is used throughout. Where the roadway is superelevated or where the grade of the roadway is excessive, then the pier cap may be sloped, still using a constant cross-section, with reinforced concrete pedestals under each beam.

3.3.4.3 The columns shall be assumed as fully fixed at the footing, and the pier designed as a rigid frame above the footing. Continuous footings founded on granular material or on piles shall be designed as a continuous beam. Individual footings shall be used on ledge.

3.3.4.4 Live loads shall be positioned on the bridge deck so as to produce maximum stresses in the pier bent. To determine the maximum live load reactions on a bent using truck loading, only one truck per lane shall be used. In the case of lane loading, only one concentrated load shall be used in conjunction with the uniform load. Stringer reactions resulting from dead and live loads (plus impact) shall be considered as concentrated loads on the pier cap.

3.3.4.5 The effect of wind on bridges shall be ignored when:

1. Pier height is less than 7.5 meters as measured from top of footing to top of pier cap.
2. Span lengths are less than 27.0 meters as measured centerline to centerline of bearings.

3.3.5 Culverts

3.3.5.1 The effective dead load of fill material on the culvert shall be taken as 19.0 kiloNewtons/cubic meter with no reduction.

3.3.5.2 Normally, sidesway of the structure shall be ignored in the design of culverts and other rigid frame structures provided that the fill placed around the structure shall be deposited on both sides to approximately the same elevations at the same time. No hydrostatic effect on the culvert shall be considered in its design.

3.3.5.3 Fillets for box culverts shown in Part II of the Bridge Manual are not to be taken into consideration in the design of the section. However, for culverts where fillets are larger than 300 millimeters, the fillets shall be considered as being haunches and the design shall include their effect on the section.

3.3.5.4 Moments, and the moment diagram, shall be calculated using member lengths based on the distances to the geometric centers of the members in accordance with the AASHTO Section 8 article on span lengths. Where critical sections are at the face of supports, the design moment shall be taken as that moment which, according to the moment diagram, occurs at the critical section location and not at the geometric center.

3.3.5.5 Design criteria (live load, impact, etc.) for the roof of a culvert shall also apply for the floor of the culvert. A maximum of one-half of the moment caused by the lateral earth pressure shall be used to reduce the positive moments in top and bottom slabs of culverts in accordance with AASHTO Section 3 for earth pressures for rigid frames.

3.4 SEISMIC DESIGN GUIDELINES

3.4.1 Dynamic Modelling

3.4.1.1 The following discussion is intended to illustrate techniques used to model bridge structures and determine their dynamic response to ground excitations. Recommendations for modeling soil-structure interaction are given.

3.4.1.2 The current practice is to model the lateral stiffness of bridge structures using a linear elastic "stick model" approach. Superstructures are modeled as a single line of beam elements. The flexural stiffness and mass of the superstructure and substructure may be determined by hand or by using readily available computer programs. These parameters are lumped at discrete locations as referenced in AASHTO. The Design Engineer shall adhere to the following guidelines when performing a seismic analysis:

1. A linear elastic model of the bridge system, with member properties determined assuming gross uncracked sections, shall be used. Essential bridges shall require a multi-mode spectral analysis if the bridge is not considered to be "regular". All others bridges require a single mode spectral analysis. The response spectrum analysis method shall be used to determine the elastic inertial forces. The definition of a regular and an essential bridge is provided in the *Seismic Retrofitting Manual for Highway Bridges (Report No. FHWA-RD-94-052)*. Bridges which require a multi-mode analysis shall use 3 modes of vibration for each span, or more, if necessary, to capture the dynamic characteristics of the bridge system.

2. Uncracked column section properties shall be used. This will result in shorter periods of vibration and higher inertial forces than would be expected should column yielding occur during the design earthquake. Pier cap properties shall be increased to simulate the stiffness of the superstructure. The resulting column moments and shears in multi-column piers should be approximately the same as a result of the assumption of a rigid pier cap.

3. Substructures shall be designed and detailed to ensure that sufficient inelastic capacity is provided. Multiple column piers are typically used due to their inherent redundancy. The process of dividing elastic column demand forces and moments, obtained from the model, by various R factors, assumes that the column detailing is sufficient to allow inelastic behavior to occur. If proper detailing is not present, such as is often the case with existing construction, the R factors must be reduced to account for a lack of ductile capacity. Recommended R factors for existing construction are specified in the section on seismic retrofitting.

4. Plastic hinging in columns occurs when their moment capacity is significantly exceeded by the elastic demand moments predicted by the model. The Design Engineer shall ensure that footings have sufficient elastic capacity to allow column hinging to occur. Controlled and tolerable damage to the columns can be readily inspected and repaired, whereas footing damage is less tolerable and more difficult to inspect. This requires determination of the column's nominal moment capacity (M_n) and verification that the footing may resist the plastic moment ($M_p=1.3M_n$) in the elastic range. In some cases (especially multiple column piers with low axial stress levels), it has been shown that the foundation design moment associated with column plastic hinging is less than would be obtained by using one half the R factor of the columns or pier to which it is attached.

3.4.2 Integral Abutment Modelling

3.4.2.1 The stiffness of the backfill retained at the abutments must be estimated to obtain a realistic distribution of forces for integral bridges. The Design Engineers shall estimate the passive soil stiffness per meter of abutment wall and multiply this value by the total abutment width to obtain the total passive resistance. The contribution of the integral abutment pile stiffness shall be added to the abutment soil stiffness to obtain the total abutment stiffness. Pile stiffnesses may be determined using simplified methods of finding the equivalent cantilever length. General information, such as the soil's classification and relative density and the pile type, may be used to determine the number of pile diameters to the point of effective fixity. More rigorous methods shall be used when the soils feature large variations in stiffness with depth or intermediate layers of soft soils. The stiffness of any piers which provide longitudinal restraint shall be determined so that the total longitudinal stiffness of the structure is estimated. The following iterative procedure is suggested:

1. Assume unit longitudinal displacement of superstructure.
2. Determine equivalent longitudinal stiffnesses of bridge substructure components which provide longitudinal restraint of substructure for assumed displacement.
3. Determine estimated total longitudinal stiffness of substructures based on assumed displacement.
4. Determine period of vibration and equivalent inertial force in accordance with AASHTO criteria.
5. Determine longitudinal displacement from equivalent inertial force and compare with assumed unit displacement.
6. Repeat steps 2 through 5 until displacement convergence is reached.
7. Determine distribution of equivalent inertial force to component substructures based upon tributary stiffnesses.

3.4.2.2 Additional Considerations.

1. When the superstructure inertia longitudinally thrusts one abutment into it's backfill the other abutment must comply by moving away from it's backfill. The abutment backfill which is resisting longitudinal movement is capable of mobilizing it's passive resistance. However, at the other abutment only the resistance of the berm can be mobilized. The resistance of the berm may be neglected due to it's limited capacity. The approximate total backfill stiffness should be modeled using one-half of the backfill stiffness at each abutment. The corresponding backfill forces from the model should be doubled for abutment design purposes.

2. For the case where the integral abutment geometries and details differ significantly for a given bridge, two separate analyses may be required. Each separate analysis will assume the full stiffness at the abutment in question and zero soil stiffness will be assumed at the other abutment.

3. The assumed abutment stiffnesses will require reduction if the resulting forces or displacements are excessive. The soil capacity shall be evaluated using accepted modern geotechnical engineering principles. When the maximum soil capacity is exceeded, the assumed abutment/soil stiffnesses are not appropriate and shall be adjusted downward and a re-analysis shall be made. This process shall continue until tolerable soil stresses and displacements are attained.

3.4.3 Substructure Seismic Performance

3.4.3.1 Abutments may be categorized as one of the following types:

1. Integral
2. Seat type (Gravity, Cantilever, etc.)

Integral abutments utilize controlled compacted backfill to absorb seismic energy. AASHTO recommends consideration be given to using integral abutments as a method of minimizing collapse potential for short span bridges. AASHTO further recommends that the integral abutment diaphragm be designed to resist passive earth pressures as a means of minimizing damage when the abutment is relied upon to resist longitudinal seismic forces. When piers are also used to provide longitudinal restraint of the superstructure the distribution of longitudinal forces shall be a function of the relative stiffness of each substructure unit.

Use of seat type abutments is often necessary where skew, span length, geotechnical, and/or constructibility issues make integral construction unfeasible. Seat type abutments have the advantage of generally simplifying the analysis, however, their use introduces a potential collapse mechanism into the structure. Bearings at seat type abutments for multiple span bridges should, where possible, allow for longitudinal translation. The use of more flexible and ductile multiple column piers is recommended, rather than the more rigid gravity or cantilever abutments, as the preferred substructure element selected for providing longitudinal restraint in multiple span bridges.

Continuous superstructures shall be utilized wherever possible on multiple span bridges. This results in serviceability improvements to the structure and eliminates a potential collapse mechanism. The skew angle and degree of curvature for bridges shall be minimized as much as possible. Skewed supports tend to promote rotation of the superstructure about a vertical axis under seismic loading.

The preferred pier type, from a seismic performance standpoint, shall feature multiple columns and be designed as a rigid frame. The effects of slenderness shall be considered. Shear and confinement reinforcement shall be spirals designed and detailed in accordance with AASHTO criteria. Hammerhead pier stems may feature interlocking spirals or ties designed and detailed in accordance with AASHTO criteria.

3.4.3.2 Seat Widths / Anchor Bolts. Design displacements shall be determined in accordance with AASHTO requirements. The minimum bearing seat length shall be the maximum value from either the elastic analysis or the value from the following formula:

$$N = (203 + 1.67L + 6.66H)(1 + 0.000125S^2) \text{ mm}$$

where:

L = length, in meters, of the bridge deck to the adjacent expansion joint or to the end of the bridge deck. For single span bridges L equals the length of the bridge deck. For hinges within a span, L is the sum of deck lengths measured from the hinge to the next expansion joint on each side of the hinge.

S = angle of skew in degrees, measured from a line parallel to the centerline of the pier to a line normal to the center line of the superstructure.

H is given by the following:

For abutments, average height in meters of piers located between abutment in question and the next expansion joint. H is measured from the average bottom of footing to the average top of pier. H equals 0 for single span bridges.

For piers, H is the pier height in meters for the pier in question.

For hinges within a span, H is the average height in meters of the two adjacent piers on either side of the hinge.

CALTRANS recommends that structures which feature intermediate joints or hinges be designed to accommodate the structure's independent movement of different parts. The inelastic time history method of analysis is one method of determining out of phase displacements. This method is fairly rigorous and requires a site specific assessment of expected ground accelerations. As a compromise, the maximum modal displacements from a multi-mode dynamic analysis for each component part of the structure may be used to determine differential displacements. Concerns over out of phase motions, as well as serviceability concerns, discourage the use of hinges within spans.

3.4.3.3 Connections. Connections are defined as those members which transfer shear or shear and axial loads between one component and another. Generally, they include bearing devices and shear keys, but do not include members which transfer bending moments. Connections for single span bridges shall designed to resist the tributary weight of the superstructure multiplied by the acceleration coefficient and the site coefficient. For single span bridges where the superstructure is restrained in the longitudinal direction at only one abutment, the weight of the entire superstructure shall be used to determine the connection design force in the longitudinal direction. For single span bridges where the superstructure is restrained in the transverse direction at each abutment, the gravity reaction at each abutment shall be used to determine the connection design force in the transverse direction.

3.4.3.4 Bearings. Preferred bearing types include elastomeric pads (plain or reinforced) with load plates factory vulcanized to the top and bottom of the pad or multi-rotational (pot or disc type). Steel rocker bearings shall not be used.

Elastomeric bearing pads detailed to deform laterally under horizontal loading from the superstructure shall be designed accordingly. The following procedure for modelling and design is suggested:

1. Estimate pad size using thermal movement and gravity dead load and live load reaction.
2. Determine $K_{PAD} = G_{MAX}$ of elastomer x $Area_{PAD} \div t_{PAD}$.
3. Determine $E_{PAD} = K_{PAD} \times t_{PAD}^3 \div I_{PAD}$.
4. Use E_{PAD} G_{PAD} and I_{PAD} to model pad as a beam element in the computer model.
5. Determine K_{PAD} using the force and displacement output for the pad element from model.
6. Repeat steps 2 through 5 until convergence of K_{PAD} values occurs.
7. Utilize forces and displacements from model to design pads in accordance with AASHTO specifications.

3.4.3.5 Isolation Bearings. Isolation bearings are considered a practical method of reducing inertial forces transferred from the superstructure to the substructure. Typically, elastomeric systems lengthen the period of vibration of the structure producing an isolation effect by deflecting rather than absorbing seismic energy. Sliding isolation systems produce the isolation effect by limiting the amount of force transferred across the sliding interface and absorbing energy through use of a displacement control device.

Isolation bearings are a useful tool in giving the Design Engineer control over the distribution of seismic forces to the various substructures. This can be beneficial in the retrofit of existing bridges which feature inadequate substructure strength and ductility. Isolation design for new construction may also be useful on essential bridges where an elastic response is desirable. Isolation design on new and existing structures considered non-essential must demonstrate cost viability through reduction of foundation costs.

The Bridge Section shall provide appropriate specifications for isolation design where necessary.

3.4.3.6 Cross Bracing at Bearings. Steel cross bracing, bolts and connection plates located between the beams or girders at the bearing locations shall be designed to transfer the seismic forces in the plane of the bracing due to the inertia of the superstructure to the bearings. The Strength Design Method (Load Factor Design) shall be used. K-bracing, using channel diaphragms, with single or double diagonal angles, shall be used at locations which require support of the deck slab. K- or X-bracing with single or double angles may be used at locations where the deck is continuous.

3.5 SUPERSTRUCTURE DESIGN REQUIREMENTS

3.5.1 Composite Design

3.5.1.1 All stringer bridges will be designed compositely with the deck. All composite beams shall be designed for composite action without the use of temporary intermediate supports during the placing and curing of the deck concrete. Composite section properties will be calculated based on the following modular ratio formula:

$$n=\frac{E_B}{E_C}$$

where n is the modular ratio, E_B is the Modulus of Elasticity of the beam material, either steel or precast concrete, and E_C is the Modulus of Elasticity of the cast-in-place deck concrete.

3.5.1.2 When calculating any composite section properties, the depth of the standard haunch as detailed in Part II of the Bridge Manual will conservatively be assumed to be zero. This is due to the fact that actual depth of this varies depending on the amount of over-cambering in the beam.

3.5.1.3 For steel beams, the effect of creep will be considered in the design of composite beams which have dead loads acting on the composite section in accordance with the provisions of AASHTO Section 10. For precast prestressed beams, the same composite properties will be used for calculating both superimposed dead load and live load stresses.

3.5.1.4 Continuous structures will be designed compositely through the negative moment region by providing negative moment reinforcing steel in accordance with AASHTO Section 10. Moments will be distributed along the beam using the gross deck concrete section properties in the negative moment region, however stresses in the negative moment region will be calculated using section properties based on the reinforcing steel alone.

3.5.1.5 Stud shear connectors shall be used for composite steel beams. The pitch of the studs need not be made in multiples of the spacing of transverse steel reinforcement in the deck slab. However, the alignment of studs should be the same as that of the transverse steel reinforcement. Shear stud spacings will be designed based on fatigue requirements, however the total number of studs so provided must be adequate for ultimate strength requirements in accordance with AASHTO Section 10.

3.5.1.6 Precast concrete beams designed compositely shall use dowels cast into the beams to transfer the horizontal shear between the beam and deck slab. These dowels shall be detailed as shown in Part II of the Bridge Manual and will be designed in accordance with AASHTO requirements for horizontal shear for composite flexural members.

3.5.2 Deck Slabs

3.5.2.1 Steel reinforcement and slab thickness shall be determined by using the design chart in Part II of Bridge Manual. If the beam spacing falls outside of the chart limits, the deck slab shall be calculated in accordance with the AASHTO Specifications of Section 3. All deck reinforcement shall be coated (either epoxy coated or galvanized).

3.5.2.2 Typical deck slabs with either a bituminous concrete wearing surface or a L.M.C. overlay shall be 30 MPa - 20 mm - 390 kg Concrete. Silica Fume Modified concrete may be substituted for regular deck concrete for bridges without bituminous concrete wearing surfaces, in which case the silica fume concrete will be used full depth without L.M.C.

3.5.2.3 Stay-in-place (SIP) forms shall be used for deck construction over rivers, active railroad tracks and roadways which will remain open to the public during construction. SIP forms will be used as detailed in Part II of the Bridge Manual. Removable forms shall be used for the forming of end diaphragms, bays with longitudinal construction joints, and overhanging portions of the deck slab. The weight of the SIP form plus the additional concrete, as shown in the chart of Part II, will be included in the design of the beam.

3.5.2.4 For most structures, especially where the roadway profile is complex, top-of-form elevations must be provided in order to set the forms such that, after all dead loads have been applied, the top of roadway will be at the correct profile elevation. Top-of-form elevations will be calculated as follows:

1. Calculate the theoretical top of roadway elevation directly over the beam at the required points along its span as specified in Part II of the Bridge Manual.

2. From this elevation, subtract the thickness of the wearing surface and deck to obtain the

in-place bottom of deck elevation. Include 5 millimeters for the thickness of the membrane, if used.

3. To the in-place bottom of deck elevation, add the total dead load deflection of the beam, excluding the deflection due to the beam's self-weight, calculated for the particular point along the beam under consideration. The result is the top-of-form elevation.

3.5.3 Distribution of Loads on Stringer Bridges

3.5.3.1 Deck slab dead load shall be distributed to each beam directly below based on tributary area.

3.5.3.2 Wearing surface/overlay superimposed dead load is to be evenly distributed among all beams.

3.5.3.3 Sidewalk/safety curb/barrier superimposed dead load, including any railing and sidewalk live load is to be distributed 60 percent to the fascia stringer and 40 percent to all the interior stringers. If a sidewalk spans over two or more stringers, the 60 percent shall be equally distributed among these stringers and the 40 percent to the remaining interior stringers.

3.5.3.4 In the case of an excessive overhang, all superimposed loads shall be distributed to the fascia stringer assuming that the deck is hinged at the first interior stringer.

3.5.3.5 All stringers under a raised median shall be designed for full dead load and live load plus impact as for an interior beam.

3.5.4 Utilities on Structures

3.5.4.1 Typical details for utility supports for the various different types of superstructures are shown in the Part II of the Bridge Manual. The Department's Utilities Engineer shall be contacted to determine what utilities are to be carried on the structure. All existing and proposed utilities shall be shown on the plans.

3.5.4.2 All utilities on stringer bridges shall be carried in the utility bay of the superstructure and shall be accessible from below. This applies also to traffic light and street light conduits on the bridge. Utilities on butted prestressed concrete beam bridges shall be carried and designed for in accordance with the guidelines for these structures in Subsection 3.8.2.

3.5.4.3 Utilities are normally installed before the deck is placed since it facilitates their installation and alignment both horizontally and vertically. Therefore, the total dead load of utilities shall be carried by the non-composite section.

3.5.4.4 For stringer bridges, the dead load of utilities is assumed to be carried by the two stringers comprising the utility bay. For structures carrying local roads with no existing utilities in the roadway, it is acceptable to show a utility bay in the superstructure and provide for a future load of 3650 Newtons/meter (1825 Newtons per meter per beam) in the design. There shall be no provision for utilities on a bridge carrying Interstate roadways.

3.5.4.5 When the utility is to be installed for a municipality, such as a water pipe, the complete support system shall be included as part of the contract. Other utilities not installed by the Contractor, such as telephone ducts and gas mains, shall be indicated on the plans as to their location in the utility bay or other designated area with the notation: TO BE INSTALLED BY OTHERS.

3.5.5 Deflection and Camber

3.5.5.1 The ratio of live load plus impact deflection to span length will not be greater than 1/1000 for all bridges with provisions for pedestrians. For bridges with no provisions for pedestrians, this ratio shall preferably not be greater than 1/1000, however under no circumstances shall it be greater than 1/800.

3.5.5.2 Camber for steel beams shall be calculated and specified on the plans as shown in Part II of the Bridge Manual.

3.5.5.3 Camber for prestressed concrete beams induced by prestressing and long term dead load deflections will be calculated according to the multiplier method outlined in the PCI *Design Handbook*. Camber will be considered when setting beam seat elevations and calculating top-of-form elevations so that for the long term condition, the top of roadway will match the design roadway profile. Cambers will not be shown on the plans nor will they be used when calculating under-bridge clearances.

3.5.6 Bearings

3.5.6.1 Careful consideration shall be given to the lateral as well as the longitudinal expansion of the superstructure where the skew angle and/or width of the structure is large. Provisions for additional restraints for these forces may be required.

3.5.6.2 Standard bridge bearing details are shown in Part II of the Bridge Manual. Bearing types not shown must receive prior approval from the Bridge Engineer before being used in the design of a bridge project.

3.5.6.3 Elastomeric bearings shall be used where ever possible for both precast concrete and steel beam bridges. Sliding plate (Lubrite) bearings will be used when large movements are expected or if the end reactions are large. Teflon sliding bearings will be used when a bearing with a low coefficient of friction is needed to minimize horizontal forces on the substructure.

3.5.7 Scuppers

3.5.7.1 Typical details for scuppers and downspouts are shown in Part II of the Bridge Manual.

3.5.7.2 The following can be used as a guide for estimating the need for scuppers and for locating them to properly drain the bridge superstructure:

1. On long bridges, scuppers should be placed about 100 meters on centers.

2. When the bridge is superelevated, scuppers are placed only on the low side.

3. On bridges, scuppers may be required when:

    i. The profile grade is less than 1%.
    ii. The profile grade is such that ponding may occur on the roadway surface. An example would be a sag curve on the bridge.

The Design Engineer shall investigate the highway drainage which may include catch basins at the approaches to the structure.

3.5.7.3 An accurate determination of the need for scuppers on bridges as well as the design of deck drainage systems will be based on the latest edition of the Hydraulic Engineering Circular No. 21: *Design of Bridge Deck Drainage* (Publication No. FHWA SA-92-010).

3.5.7.4 When scuppers are needed, they shall generally be placed near a pier and on the upgrade side of a deck joint. Care shall be taken to ensure that scupper outlets will not result in run-off pouring or spraying onto either the superstructure beams or the piers.

3.5.7.5 Horizontal runs of drain pipes shall not be used. Cleanouts shall be accessible for maintenance purposes and shall be placed, in general, at every change in the alignment of the downspouts.

3.6 STEEL SUPERSTRUCTURES

3.6.1 General

3.6.1.1 Uncoated weathering steel, AASHTO M270 Grade 345W, shall be the primary option for all steel bridges constructed by the Department. If the Design Engineer determines that the use of uncoated weathering steel is not prudent for a specific location, then the Bridge Engineer must concur with this decision before design begins. Guidelines for the use of weathering steel are contained in the FHWA Technical Advisory T5140.22.

3.6.1.2 For all steel stringer bridges, the ratio of the length of span to the overall depth of the beam (depth of the beam plus thickness of the design slab) shall preferably not be greater than 21. This ratio may be exceeded where, due to clearance and profile requirements, a shallower structure is required, however under no circumstances will the span to depth ratio be less than 25. For continuous spans, the span length shall be considered as the distance between dead load points of contraflexure.

3.6.2 Rolled Beams

3.6.2.1 The minimum cover plate thickness shall be 12 millimeters. For economy, it is preferable to use the same thickness cover plate on all similar size beams.

3.6.2.2 Bottom cover plates will be terminated not more than 500 millimeters from the centerline of bearings, however the Design Engineer must still check the fatigue stress range at the termination point.

3.6.2.3 Top cover plates, when used in the negative moment regions of continuous beams shall extend beyond the theoretical end by at least the terminal distance as defined in AASHTO Section 10, however, the actual termination point will be determined by fatigue considerations.

3.6.2.4 The Design Engineer will design all cover plate to flange welds or will verify the adequacy of the minimum weld sizes. Welding symbols, with dimensions where required, will be shown on the plans for all welds.

3.6.3 Welded Plate Girders

3.6.3.1 Minimum sizes for webs, flanges and welds, as well as detailing guidelines for plate girders, are given in Part II of the Bridge Manual.

3.6.3.2 The Design Engineer shall first consider a web design that does not require the use of transverse stiffeners. If the required web thickness is excessive, a stiffened web will be used, however the spacing of the transverse stiffeners will be as large as possible. Cross frame connection plates can be used as stiffeners if they meet the AASHTO requirements for stiffener plates. For aesthetics, transverse stiffeners shall not be placed on the outside face of the exterior girders.

3.6.3.3 Longitudinal stiffeners will be avoided unless required by design to avoid excessively thick, transversely stiffened webs. Typically, longitudinal stiffeners should only be considered for very deep girders. If longitudinal stiffeners are used, they shall be placed on the opposite side of the web from the un-paired transverse stiffeners. Under no circumstances will longitudinal and transverse stiffeners be allowed to intersect.

3.6.3.4 Flanges shall be sized as required by design, however for shipping and erection safety, the ratio of the length to the width of the compression flange shall be limited to 100 where practical even at the expense of some additional steel.

3.6.3.5 The flange width may vary over the length of the girder, however constant width flanges are preferred. Top and bottom flanges need not be of the same width.

3.6.3.6 Due to the cost of making a full penetration welded flange splice, the number of changes to the flange thickness will be kept to a minimum. When a girder flange is butt spliced, the thinner segment shall be not less than one-half the thickness of the adjoining segment.

3.6.3.7 All welding and fabrication of plate girders shall be in conformance with the AASHTO/AWS *Bridge Welding Code* (ANSI/AASHTO/AWS D1.5). Any welds that are not prequalified welds shall be detailed on the plans. Welding symbols, with dimensions where required, will be shown on the plans for all welds.

3.6.4 Splices and Connections

3.6.4.1 In general, all field connections shall be made with high strength bolts conforming to the requirements of AASHTO M164. All structural connections shall be designed as Slip-Critical connections. Without special permission from the Bridge Engineer, AASHTO M253 bolts will not be used.

3.6.4.2 Field splices in beams and girders, when necessary, shall generally be located as follows:

Continuous Spans:	Points of Dead Load Contraflexture.
Simple Spans:	Quarter Point.

3.6.4.3 Field splices shall be bolted splices using M22 high strength bolts and shown with complete dimensioning on the plans. Filler plates shall not be less than 3.5 millimeters thick. Field splices of flanges and webs shall not be offset.

3.6.4.4 Transverse stiffeners will be located as specified in Part II of the Bridge Manual so that they do not coincide with the splice plates. If stiffeners in the area of a bolted splice are unavoidable, steel angles shall be used as stiffeners instead of plates welded to the splice plates.

3.6.4.5 All shop welded splices shall have flange splices offset 1.5 meters from the web splice. As welded flange splices are costly, a savings of approximately 300 kilograms of steel should be realized in order to justify the cost of the flange splice.

3.7 PRESTRESSED CONCRETE SUPERSTRUCTURES

3.7.1 Standard Beam Sections

3.7.1.1 Standard AASHTO - PCI precast concrete Deck, Box, or New England Bulb Tee beam sections as detailed in Part II of the Bridge Manual will be used to construct precast concrete bridge superstructures. Other sections may be used where the situation precludes the use of standard sections and prior approval has been obtained from the Bridge Engineer, or where so permitted by the Bridge Manual.

3.7.1.2 The standard beam sections were developed in conjunction with PCI New England and meet the fabrication tolerances and practices of most regional precasters. If a particular design requires that major alterations be made to the standard details, such as the placement of strands in locations other than those shown or different reinforcing details, it will be the Design Engineer's responsibility to ensure that the design can be fabricated by a majority of area precasters.

3.7.1.3 In butted precast beam superstructures, the beams should be placed to follow the roadway cross section as much as practical. On bridges with a Utility Bay under the sidewalk, the sidewalk beam need not be placed to follow the cross slope, unless a deeper sidewalk depth is required over this beam for railing/traffic barrier attachments. For New England Bulb Tee or spread Box beam bridges, the beams will be placed plumb and a deck haunch deep enough to accommodate the drop of deck across the width of the beam flange will be provided.

3.7.2 Materials

3.7.2.1 Concrete Stresses. Standard designs shall be based on a concrete compressive strength (f'_c) of 45 MegaPascals. Concrete compressive strengths greater than this will not be used unless prior approval is given by the Bridge Engineer and it has been verified that most regional precasters are capable of producing quality concrete at these strengths. Concrete compressive strength at release (f'_{ci}) shall be taken as 27 MegaPascals. Higher concrete release strengths, up to 0.8 f'_c, may be used only if required by design in order to avoid going to a deeper beam. Concrete release strengths greater than 0.8 f'_c will not be used.

3.7.2.2 Prestressing Strands. MassHighway Specifications call for the use of 13 millimeter diameter, Low Relaxation strands meeting the requirements of AASHTO M203. Strands shall not be epoxy coated. MassHighway Specifications further require that beams be fabricated with the prestressing strand layout as shown on the plans.

3.7.2.3 For the reduction of tensile stresses at the ends of Box and New England Bulb Tee beams, either draped or de-bonded strands can be used. For Deck beams, due to their construction, draped strands cannot be used. Mixing draped and de-bonded strands in a beam is permitted.

3.7.2.4 Where de-bonded strands are used, no more than twenty five (25%) of the total number of strands may be de-bonded. The spacing between de-bonded strands in a layer shall be 100 millimeters minimum. The outermost strands of each layer will not be de-bonded.

3.7.2.5 Where draped strands are used, the total hold down force of all draped strands for each beam should not exceed seventy five (75%) of the total beam weight.

3.7.2.6 Reinforcing Steel. All non-prestressed reinforcement shall be epoxy coated Grade 420 reinforcing steel. It is the Design Engineer's responsibility to detail the beams so that all reinforcement will be embedded, developed or lapped as required. In the case of Deck or Box beams, the size of the void can be reduced (or eliminated for Deck beams only), as noted in Part II, to permit proper bar development.

3.7.2.7 Utility Supports. The steel for all utility supports shall conform to AASHTO M270 Grade 250, and shall be galvanized. All inserts for the attachment of utilities will be cast into the beam at the time of its fabrication. Inserts that are being provided for a future utility installation shall be furnished with a plastic plug the same color as the concrete. Drilling of holes for attachments will not be permitted once the beam has been cast.

3.7.3 General Design Requirements

3.7.3.1 All prestressed beams will be designed according to the latest AASHTO *Standard Specifications for Highway Bridges*, except where modified or amended by this section. The beams will be designed by the Allowable Stress Method for all service loading conditions the beam will be subjected to during its life. The ultimate strength of the beam will be checked for the final service condition by using the Load Factor Method.

3.7.3.2 Beams will be designed to have zero tension in the precompressed tensile zone under final service conditions after all losses have occurred. If the only way to eliminate these tensile stresses is to go to the next larger beam size and the depth of structure is critical, tensile stresses up to a maximum of $.249\sqrt{f'_c}$ will be permitted to avoid going to the next larger beam size. Tensile stresses greater than this may be used only with the permission of the Bridge Engineer.

3.7.3.3 Transverse stirrups shall be designed in accordance with AASHTO requirements for shear in prestressed concrete beams, except that neither the minimum bar sizes nor the maximum spacings, as noted in Part II, shall be violated. For butted Box beams, the top bars (straight and U shaped) shall be designed as slab reinforcement and spaced accordingly; the bottom #13 U-bars shall be designed to satisfy shear requirements, however they will be spaced at a multiple of the top bars. Each bottom U-bar shall be lapped with a top U-bar to form the transverse stirrups.

3.7.3.4 End transverse stirrups and vertical stirrups shall be designed to meet the AASHTO requirements for Anchorage Zones of prestressed concrete beams, Article 9.21. If absolutely necessary, #16 bars may be used, in which case the lap and embedment lengths would have to be adjusted.

3.8 DESIGN PROCEDURES

3.8.1 Design of Butted Deck and Box Beam Bridges

In order to ensure the adequate capacity of all beams in a butted Deck or Box beam superstructure, the beams will be designed according to following 3 step procedure. If beams of different Moments of Inertia are used together in a butted superstructure, the distribution of superimposed Dead Loads to each beam shall be in proportion to its Moment of Inertia according to the following formula:

$$L.D.F._k = \frac{I_k}{\sum_{i=1}^{n} I_i}$$

where $L.D.F._k$ is the load distribution factor for the *k* th beam, I_k is the Moment of Inertia of the *k* th beam, and $I_1 \ldots I_n$ are the Moments of Inertia of the beams over which the load is distributed.

STEP 1: Design each beam for: the beam's own dead weight, including all solid sections; the portion of the superimposed Dead Loads and sidewalk Live Load carried by the beam, calculated using the above load distribution factor; the portion of the design Live Load plus Impact carried by the beam, calculated using the AASHTO load fraction. Since the AASHTO load fraction is a function of the beam width and Moment of Inertia, no further distribution of the design Live Load using the above load distribution factor is required.

STEP 2: Check all butted beams under the sidewalk, safety curb or barrier section for the following cases:

Case A: Beam Dead Load + (Dead Load: the sidewalk slab directly above this beam, or the safety curb including railing/barrier, or the CF barrier, plus all Dead Loads cantilevered out from this beam) + (for sidewalks only: the sidewalk railing/barrier Dead Load and sidewalk Live Load distributed to the beam using the above load distribution factor).

Case B: Beam Dead Load + (Dead Load: the sidewalk slab directly above this beam, or the safety curb including railing/barrier, or the CF barrier, plus all Dead Loads cantilevered out from this beam) + (for sidewalks only: the sidewalk railing/barrier Dead Load distributed to the beam using the above load distribution factor) + (Live Load: **a)** for a sidewalk: one half of a truck load for sidewalks narrower than 2.4 meters, a full truck load for sidewalks wider than 2.4 meters, plus Impact, distributed to the beam using only the above load distribution factor and not the AASHTO load fraction; **b)** for a safety curb/barrier: one line of wheels located 300 millimeters from the face of the barrier or curb, plus Impact).

For either Case A or B: when using the above load distribution factor formula, the sum of $I_1 \ldots I_n$ will include only those beams which are under the sidewalk for any part of their width; the allowable compressive stress shall be increased by 50% and the allowable tensile stress in the precompressed tensile zone shall be taken as: $.498\sqrt{f'_c}$; the concrete strength at release shall not be increased beyond the limits specified by Paragraph 3.7.2.1, *Concrete Stresses*; the beams may be designed composite with the sidewalk slab, provided that the dowels cast into the beams have been designed for horizontal shear as specified in AASHTO.

STEP 3: If under Step 2 the beam becomes overstressed, re-design the beam for Step 2 loading and allowable stresses.

If this procedure results in a slight increase in the number of strands over the beam design from Step 1, consideration should be given for making all interior beams of the same design. If the above procedure results in a substantial increase in the number of strands over the beam design from Step 1, then two or more beam designs may be necessary.

3.8.2 Utilities On Butted Deck and Box Beam Bridges

3.8.2.1 General. Utilities shall be located as shown in Section 4.3 of Part II of the Bridge Manual. Preference shall be given to locating the utilities in an utility bay under the sidewalk wherever possible. Under no circumstances will utilities be located inside Deck or Box beams within the void area.

3.8.2.2 The utility supports shown in Part II of the Bridge Manual represent acceptable configurations. Where members and bolts are provided, these supports may be used up to the limits shown without further design. These supports may have to be altered depending on the utility. If an increase in the side clearance of the utility bay is required, the L 102 x 102 x 12.7 attached to the side of the beam may be replaced by an attachment using a section of WT. In these cases, the Design Engineer is responsible for the design of the utility supports. In all cases, the utility supports must be adequately detailed on the plans.

3.8.2.3 Sidewalk Utility Bay - Sidewalk Beam Design. The sidewalk beam as defined in Section 4.3 of Part II may be either a standard AASHTO - PCI Deck or Box beam section or a special rectangular solid precast prestressed beam. I-beams shall not be used for this application. If the sidewalk is wide enough to accommodate two sidewalk beams, provide longitudinal joints and transverse ties as for normal butted beams. If there are two or more sidewalk beams, distribute the superimposed Dead and Live Loads described in the procedure to each sidewalk beam using the load distribution formula of Subsection 3.8.1.

The beam(s) may be designed to be composite with the sidewalk slab, provided that the dowels cast into this beam have been designed for horizontal shear as specified in AASHTO. The effective width of the slab shall extend to mid-bay.

STEP 1: Design the beam for the following Dead and Live loads and allowable stresses:

Dead Loads: Beam Dead Load + (one half of the weight of the utilities in the utility bay) + (the weight of any Dead Loads cantilevered from the exterior of the beam) + (sidewalk slab directly above the beam plus one half the slab over the utility bay) + (railing/barrier Dead Load, distributed 60% to the sidewalk beam and 40% to the roadway beam(s)).

Live Load plus Impact: place a truck on the sidewalk with a the wheel line 300 millimeters from the face of the railing/barrier and distribute as follows: if the wheel line is located anywhere over the sidewalk beam, apply 100% of the wheel line load to the sidewalk beam; if the wheel line is located over the utility bay, distribute the wheel line load assuming the sidewalk slab acts as a simple beam. Depending on the width of the sidewalk, use one or both wheel lines.

Concrete Stresses: the allowable concrete compressive stresses shall be increased 50% and the allowable tensile stress in the precompressed tensile zone shall be taken as: $.498\sqrt{f'_c}$. No increase will be allowed in the initial concrete strengths at release.

STEP 2: Check the sidewalk beam(s) as designed in Step 1 in accordance with Subsection 3.7.3, for the following loads:

Dead Loads: same as Step 1 Dead Loads.

Live Load: the AASHTO sidewalk Live Load located on that strip of sidewalk directly over the sidewalk beam(s) which extends from the face of the railing/barrier to the midpoint of the utility bay.

3.8.2.4 Sidewalk Utility Bay - Roadway Beam Design. The butted roadway beam(s) under the sidewalk and adjacent to the utility bay shall be designed according to the procedure in Subsection 3.8.1, modified as follows. Dead Loads shall be all sidewalk Dead Loads not assigned to the sidewalk beam(s). The load carrying contribution of the sidewalk beam(s) will be ignored. Assume that the sidewalk slab acts as a simple beam for distributing truck Live Loads. This beam may be designed composite with the sidewalk slab, using the same criteria as for the sidewalk beam. In no case shall this beam have less load carrying capacity than the other butted roadway beams.

3.8.2.5 Sidewalk Utility Bay - Sidewalk Slab Design. The sidewalk slab shall be designed for the differential deflection between the butted roadway beams and the sidewalk beam(s).

STEP 1: Calculate the deflection of the butted roadway beams by placing design trucks in each of the actual travel lanes (not the AASHTO design lanes) and assuming that all butted roadway beams are acting together.

STEP 2: Calculate the equivalent uniformly distributed load (per meter of beam) which would cause the same deflection in the sidewalk beam as calculated in Step 1. Use the composite section properties if the sidewalk beam is being designed compositely. If there are two or more sidewalk beams, calculate the load that would deflect all sidewalk beams at once.

STEP 3: For design, the sidewalk slab will be considered a cantilevered beam with a length equal to the clear width of the utility bay. The design load shall be the uniform load calculated in Step 2 and applied at the free end of the cantilever. Assume the section to be singly reinforced and use the smallest *d* dimension. The required steel area shall be provided for both top and bottom transverse slab reinforcement. Spacing of these bars should be at a multiple of the sidewalk dowels of the first roadway beam.

STEP 4: If excessive steel areas are required, consideration should be given first to increasing the depth of the sidewalk slab and, second, by providing intermediate diaphragms. The intermediate diaphragms need only be designed for the load in excess of the slab capacity.

3.8.2.6 Exterior Utility Supports. Whenever a utility is attached to the exterior of a butted beam bridge, the torsional effect of such an attachment may cause unequal reactions at the bearings. This effect may be compounded by additional eccentric loads, such as either a sidewalk overhang or a safety curb with a railing/barrier and which does not extend over to the second interior beam. To help equalize the reactions at the bearings, consideration will be given to increasing the number of transverse ties and/or the amount of the post-tensioning force.

3.8.3 Continuity Design for Butted Deck and Box Beam Bridges

3.8.3.1 General. The closure pour for continuity, as detailed in Part II of the Bridge Manual, is also intended to provide the longitudinal and transverse restraint for the bridge for seismic and other design loads. The #16 reinforcing bar hoops placed in the closure pour as well as the #16 hoops in the pier cap adjacent to the shear key will be designed for the longitudinal loads. The transverse shear requirement will also be checked. If the continuity bars alone are insufficient as shear dowels, additional shear dowels projecting into the closure pour may be cast into the end of the beam.

Dead Load deflections in the design of simple span butted Deck and Box beam bridges made continuous over two or more spans, especially if continuity is being made between un equal spans.

3.8.3.3 Butted Deck and Box beam bridges made continuous will be designed according to the procedure outlined below. The full effect of continuity will not be used to reduce the positive superimposed Dead Load and Live Load moments. All design of the reinforcement within the closure pour will be per prestressed beam and based on its width. NCHRP Report 322, *Design of Precast Prestressed Bridge Girders Made Continuous*, is recommended as a reference for the design of continuous prestressed girders.

STEP 1: Design all beams as a simple span for positive moment prestressing.

STEP 2: Calculate the negative superimposed Dead Load and Live Load plus moment envelopes assuming that the beam is fully continuous.

STEP 3: The actual continuity steel provided shall be the smaller of either Case A or B:

Case A: Using the Strength Design Method, calculate the steel area required for the maximum negative moment at the pier from Step 2. The design concrete compressive strength shall be that of the prestressed beam. The compressive stress in the ends of the beams at the piers from the combined effect of prestressing and negative Live Load/superimposed Dead Load moments shall not exceed 0.6 f'_c.

Case B: Using Strength Design criteria, calculate ρ_b for the section. The maximum steel area to be provided shall not exceed 0.5 ρ_b. The design concrete compressive strength shall be that of the prestressed beam.

STEP 4: Using the negative moment envelope, determine the cut-off point for the continuity reinforcement. For Box beams, the cut-off shall be where the steel area provided by the standard #13 longitudinal steel is sufficient for the negative moment. For Deck beams, the cut-off will be either where the negative moment envelope is zero or where the concrete stresses due to negative moment are within AASHTO allowables for concrete tension.

Since it is not intended to restrain the rotation of the beam end at the closure pour due to creep induced camber growth, no provisions shall be made for a positive moment connection at the continuity supports to resist the positive restraint moment that may develop.

3.8.3.4 Bridges With Sidewalk Utility Bay. Follow the same procedure as above. If the sidewalk slab is being designed compositely with the sidewalk beam, the continuity reinforcement may be placed in the slab instead of the beam.

3.8.4 Design of Top Slab Reinforcement for Butted Box Beams

For butted Box beams, the top slab steel must be designed for all applied Dead Loads plus Live

Load and Impact. The slab shall be modeled as a beam with two fixed ends. For Dead Loads calculate the negative moment at support. For Live Load, the AASHTO MS18 live load moment formula for the design of slabs, as given in AASHTO Article 3.24.3.1 - Case A, may be used in lieu of a more refined analysis technique. The 0.8 factor for continuity of Article 3.24.3.1 does not apply and shall not be used. The design moment shall be the sum of the absolute values of the Live Load plus Impact and Dead Load moments. The design of the reinforcing steel shall take into account the higher strength and modulus of elasticity of the concrete. The steel areas so calculated shall be used for both the top slab steel bars, which shall be placed together in pairs.

3.8.5 Elastomeric Bridge Bearings

3.8.5.1 General. Elastomeric bearing pads shall be designed and fabricated in accordance with the requirements of Section 14, Division I and Section 18, Division II of the latest edition of the AASHTO, and as modified by this section. Holes in the either the elastomer or the steel reinforcement plates are not allowed.

3.8.5.2 Elastomer Material Properties. Hardnesses over 70 durometer are not allowed. The shear modulus shall be taken as that value which is most conservative for each part of the design. Elastomers with a shear modulus greater than 1380 kiloPascals or a hardness of greater than 60 durometer shall not be used for reinforced bearings. Use elastomer classified as low temperature Grade 3.

3.8.5.3 Reinforcement shall be steel laminates conforming to AASHTO M183 or equivalent and shall have a minimum thickness of 3.5 millimeters. A minimum elastomer cover of 3 millimeters shall be provided for steel reinforcement plates.

3.8.5.4 Design. For butted concrete box and deck beams with a span length of fifteen (15) meters or less, use plain, un-reinforced elastomeric pads, 25 millimeters thick by 130 millimeters wide, detailed and placed as shown in Part II of Bridge Manual.

For all other applications, bearings shall be designed using design **Method A** as defined in AASHTO Article 14.4. Effects of long term deflections and longitudinal slope shall be considered unless it can be demonstrated by sufficient calculations that they are negligible.

For substructure design, the forces imposed by the bearing on the substructure shall be calculated as specified in AASHTO.

3.8.5.5 Tapered layers of elastomer in reinforced pads are not permitted. If tapering of the bearing is necessary (e.g. to accommodate longitudinal slopes), it shall be accomplished as follows:

1. For concrete beams: taper only the top steel reinforcement plate and provide a cover layer of elastomer with constant thickness.

2. For steel beams: provide a tapered steel sole plate, vulcanized to the top layer of elastomer, and field welded to the bottom flange.

4. All connection details.
5. Diaphragm details along with their connections.
6. Utility support details.
7. Shear connector details.
8. Bearing details.

4.2.2.7 Deck Detail Sheets. These sheets will show all details and dimensions necessary for constructing the bridge deck and all related elements. At a minimum these details will include:

1. Typical superstructure cross section.
2. Deck details including required thickness and reinforcement.
3. Haunch detail.
4. Top of Form elevations (if required).
5. Sidewalk, safety curb, barrier details including reinforcement.
6. Reinforcement details for continuous bridges including pouring sequences if required.

4.2.2.8 Miscellaneous Detail Sheets. These sheets will show all additional details necessary to construct the bridge structure. These sheets may include the following:

1. Armored joint details.
2. Railing/barrier end posts.
3. Railing details (MHD standard sheet).
4. Type II Protective Screen details (MHD standard sheets).

4.2.2.9 The following are standard general construction notes. The wording and content may vary to suit the particular needs of the project:

GENERAL NOTES

DESIGN:

IN ACCORDANCE WITH THE 19-- SPECIFICATIONS OF THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS WITH CURRENT INTERIM SPECIFICATIONS THROUGH 19--, FOR MS18 LOADING. *(If the bridge carries Interstate traffic, the note shall be modified by adding:* MODIFIED FOR MILITARY LOADING. *If the design loading is different from MS18, specify the actual design loading.)*

If the bridge carries a railroad, substitute the following note:
IN ACCORDANCE WITH THE 19--SPECIFICATIONS OF AREA FOR RAIL BRIDGES, INCLUDING INTERIM SPECIFICATIONS THROUGH 19--.

BENCH MARK:

Give location and elevation of control bench mark. It is to be noted that if a structure is in a pre-loaded area and the nearest bench mark becomes covered, another benchmark outside the area should be selected. Following the elevation of the bench mark, the following note should be added:

ELEVATIONS ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988 *(if the survey was based on the National Geodetic Vertical Datum (NGVD) of 1929, change the note accordingly).*

DATE:

TO BE PLACED ON THE INSIDE FACE OF THE -- AND -- END POSTS. A SHEET SHOWING SIZE AND CHARACTER OF NUMERALS WILL BE FURNISHED. THE DATE USED SHALL BE THE LATEST YEAR OF CONTRACT COMPLETION AS OF THE DATE THE FIRST END POST IS CONSTRUCTED. ALL END POSTS SHALL FEATURE THE SAME DATE.

SURVEY NOTEBOOKS:

List survey notebooks used in the preparation of construction drawings:
Baseline _________, Details _________, Cross-sections _________, or, if electronic survey was used, state that copies of files may be obtained from the Massachusetts Highway Department.

SCALES:

SCALES NOTED ON THE PLANS ARE NOT APPLICABLE TO REDUCED SIZE PRINTS. DIVIDE SCALES BY 2 FOR HALF-SIZE PRINTS (A3).

FOUNDATIONS:

FOUNDATIONS MAY BE ALTERED, IF NECESSARY, TO SUIT CONDITIONS ENCOUNTERED DURING CONSTRUCTION, WITH THE APPROVAL OF THE ENGINEER.

UNSUITABLE MATERIAL:

ALL UNSUITABLE MATERIAL SHALL BE REMOVED WITHIN THE LIMITS OF THE FOUNDATIONS OF THE STRUCTURE, AS DIRECTED BY THE ENGINEER.

ANCHOR BOLTS:

If none of the these conditions is present:
- *a. Uplift*
- *b. The bridge has a severe skew*
- *c. There is more than the usual amount of reinforcing steel in the bearing area.*

the following note may be used:
ALL ANCHOR BOLTS SHALL BE SET BY TEMPLATE BEFORE THE CONCRETE IS PLACED, EXCEPT AT ABUTMENTS, WHERE CORING AND GROUTING MAY BE USED AT THE CONTRACTOR'S OPTION, PROVIDED THAT THE METHOD OF INSTALLATION WILL NOT CUT REINFORCING STEEL.

Otherwise, use the following note:
ALL ANCHOR BOLTS SHALL BE SET BY TEMPLATE BEFORE THE CONCRETE IS PLACED.

REINFORCEMENT:

REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A615M GRADE 420. UNLESS OTHERWISE NOTED ON THE PLANS, ALL BARS SHALL BE LAPPED AS FOLLOWS:

MODIFICATION CONDITION	#13 BARS	#16 BARS
1. NONE	520 mm	650 mm
2. 300 mm OF CONCRETE BELOW BAR	730 mm	910 mm
3. COATED BARS, COVER < $3d_b$, OR CLEAR SPACING < $6d_b$	780 mm	980 mm
4. COATED BARS, ALL OTHER CASES	600 mm	750 mm
5. CONDITION 2. AND 3.	880 mm	1110 mm
6. CONDITION 2. AND 4.	840 mm	1050 mm

IF THE ABOVE BARS ARE SPACED 150 MILLIMETERS OR MORE ON CENTER, THE LAP LENGTH SHALL BE 80% OF THE LAP LENGTH GIVEN ABOVE. ALL OTHER BARS SHALL BE LAPPED AS SHOWN ON THE PLANS.

4.3 SUBMISSION OF CONSTRUCTION DRAWINGS

4.3.1 First Submission Of Review Prints

Two (2) sets of construction drawings and one (1) set of design calculations along with one (1) set of independent design check calculations shall be submitted to the Department for initial review. These plans, except for quantities, shall be in a completely finished state, fully designed and checked before being submitted to the Department. The date of submission should be stamped on the first sheet of the plans. The design calculations and the independent check calculations shall also be identified, at a minimum, with the Bridge No. and BIN (Bridge Identification Number).

If the structure carries a railroad, an additional three (3) sets of prints and three (3) sets of design calculations shall be submitted for review by the railroad involved. If excavation for the construction of any bridge or wall requires sheeting for the protection of an existing railroad embankment, three (3) sets of drawings showing the proposed sheeting and three (3) sets of supporting design calculations shall be submitted for railroad review.

The Bridge Section will review the initial submission of construction drawings, and return marked-up prints to the Design Engineer for reconciliation of comments.

4.3.2 Second Submission Of Review Prints

After all Bridge Section review comments have been reconciled, the Design Engineer shall submit three (3) sets of updated construction drawing prints to the Department. At this time the Design Engineer shall also submit two (2) sets of Special Provisions and two (2) sets of Preliminary Estimate of Quantities.

The construction drawings shall be distributed as follows:

1. Consultant Review Section.
2. Federal Highway Administration (if required).

4.3.3 Submission Of Mylars

Review comments made by the FHWA will be sent to the Design Engineer for response in writing. When the Department receives FHWA approval, the Design Engineer will submit construction drawing mylars to the Bridge Section for final back-check. Mylars submitted by outside consultants shall have the name and address of the Design Engineer as well as the stamp and signature of a Registered Professional Engineer incorporated into the Standard Title Block, as shown on Drawing No. 1.1.4 of Part II of the Bridge Manual.

4.4 REVISIONS TO CONSTRUCTION DRAWINGS

4.4.1 Approval Procedure

4.4.1.1 General. It may be necessary to revise the contract drawings for a variety of reasons such as errors, omissions, changes in design conditions, changes requested during construction, etc. The procedure for initiating and approving these changes is outlined below and is taken from the Commonwealth of Massachusetts Department of Public Works (former name of MHD) Standard Operating Procedure No. CSD-24-16-1-000, *Structural Approval Procedures*, dated December 1, 1977.

4.4.1.2 Errors on the Construction Plans. If errors on the plans or in the specifications are found by the Design Engineer or Contractor's fabricator, the information with recommended corrective action shall be referred through the Design Engineer directly to the Bridge Engineer. Only a copy of the letter shall be sent to the District Highway Director and the Construction Engineer. The Bridge Engineer will review the corrective action for approval and the Design Engineer will distribute revised plans and/or shop drawings. If revisions to the plans are not necessary, the Bridge Engineer will inform the Construction Engineer who in turn will inform the Contractor through the District Highway Director.

Errors discovered by all others will be processed through normal department channels.

4.4.1.3 Requested Changes. No request for any change shall be initiated unless all of the four following questions can be answered in the affirmative:

1. Is the change in the public interest?
2. Does it provide an equal or better material or product than originally specified?
3. Does it provide a better method of construction than originally planned?
4. If the Contractor benefits from the change, is there a corresponding benefit to the Department?

The Construction Engineer will determine the validity of the reasons given for any change.

I. Changes Requested by the Fabricator:

These requests shall be submitted by the Fabricator to the Design Engineer with copies of the letter to the Prime Contractor and the District Highway Director. The Design Engineer

MASS HIGHWAY

BRIDGE MANUAL - PART II

BRIDGE MANUAL
PART II: STANDARD DETAILS
DRAWING NUMBER, DESCRIPTION, DATE OF ISSUE

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4.4.12 Roadway Section, Type B Beams . . . . December 1995
4.4.13 Roadway Section, Type BI Mod. & BI Beams . . . . December 1995
4.4.14 Construction Notes for Details at Abutment . . . . December 1995
4.4.15 Pavement Sawcut Detail & Designer Notes . . . . December 1995
4.4.16 Sidewalk Section . . . . December 1995
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4.5 PIER DETAILS

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4.5.4 Vertical Section @ Pier End (w/o Utility Bay) for Beam Continuity December 1995
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4.5.13 Plan Section @ Pier End for Joint at Pier . . . . December 1995
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5.1.8 Coping Details for Diaphragm Connection Plates . . . . December 1995

5.2 PLATE GIRDERS
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5.2.2 Designer Notes . . . . December 1995
5.2.3 Typical Welded Girder . . . . December 1995
5.2.4 Stiffener Attachment Details . . . . December 1995
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5.2.6 Parabolic Haunched Girders . . . . December 1995
5.2.7 End Cross Frame Details . . . . December 1995
5.2.8 Intermediate Cross Frame Details . . . . December 1995
5.2.9 Utility Support Details at Cross Frames . . . . December 1995
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5.3.2 Roadway Section (w/ Joint) . . . . December 1995
5.3.3 Construction Notes for Details at Abutments . . . . December 1995
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9.3.2 Section Thru Sidewalk . . . . December 1995
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9.3.4 Top of U-Wingwall Details - Safety Curb Side . . . . December 1995
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9.4 CP-PL2 BARRIER
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9.4.2 Modifications for Precast Butted Beam Bridges . . . . December 1995
9.4.3 Section Thru Sidewalk . . . . December 1995

9.4.4 Section Thru Overhanging Sidewalk . . . . December 1995
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9.4.7 Top of U-Wingwall Details - Sidewalk Side . . . . December 1995

9.5 CF-PL2 BARRIER

9.5.1 Typical Section . . . . December 1995
9.5.2 Modifications for Precast Butted Beam Bridges . . . . December 1995
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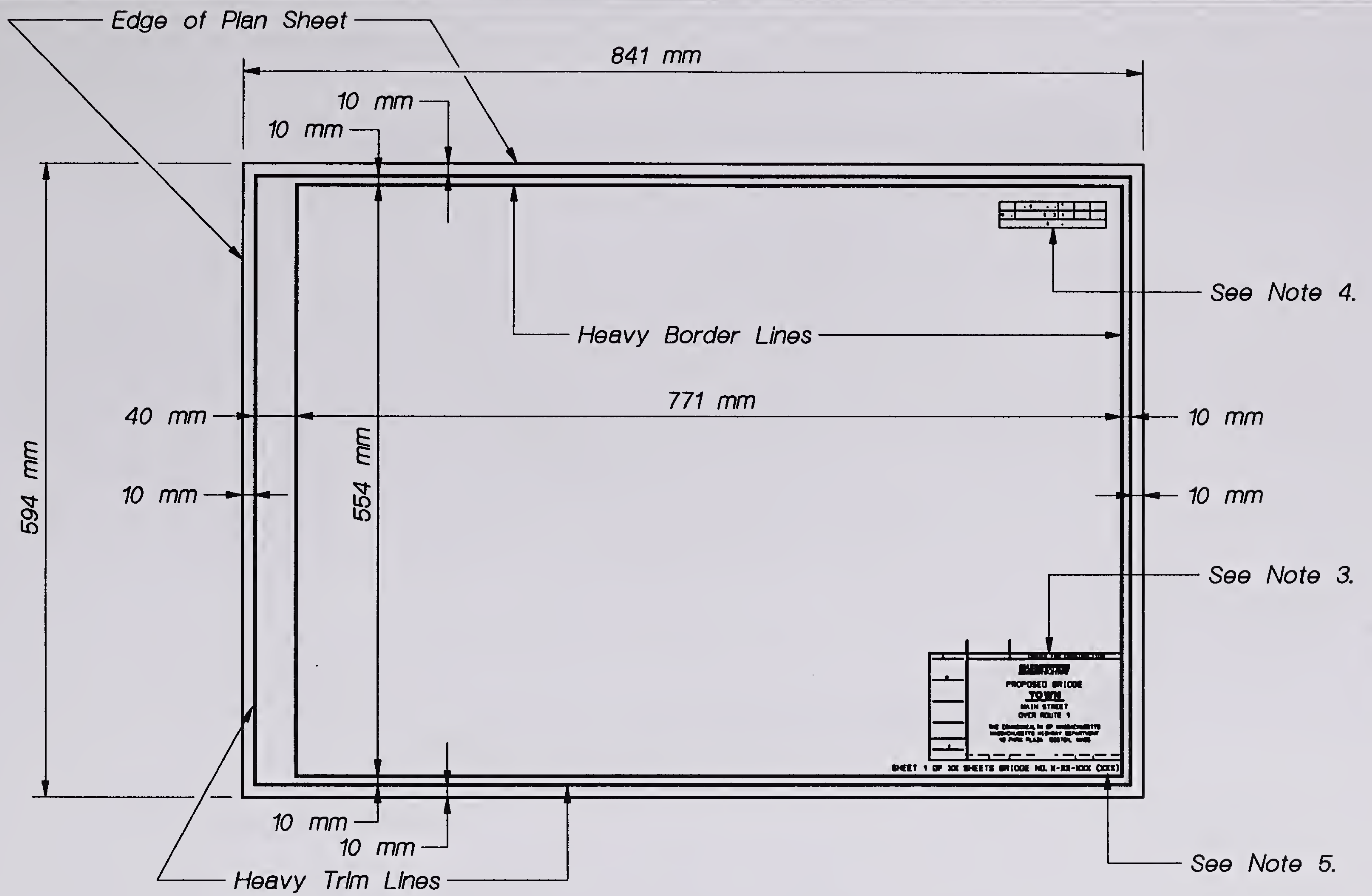


NOTES:

1. The above drawing is not drawn to scale.
2. See Dwg. No. 1.1.2 for Standard Subsequent Sheets.
3. See Dwg. No. 1.1.3 for In-House Design Title Block.
   See Dwg. No. 1.1.4 for Consultant Design Title Block.
4. See Dwg. No. 1.1.5 for Federal Aid Block.
5. Bridge with single Bridge Identification Number (B.I.N.) shown.
   For bridges with multiple B.I.N.'s, see Dwg. No. 1.1.5.

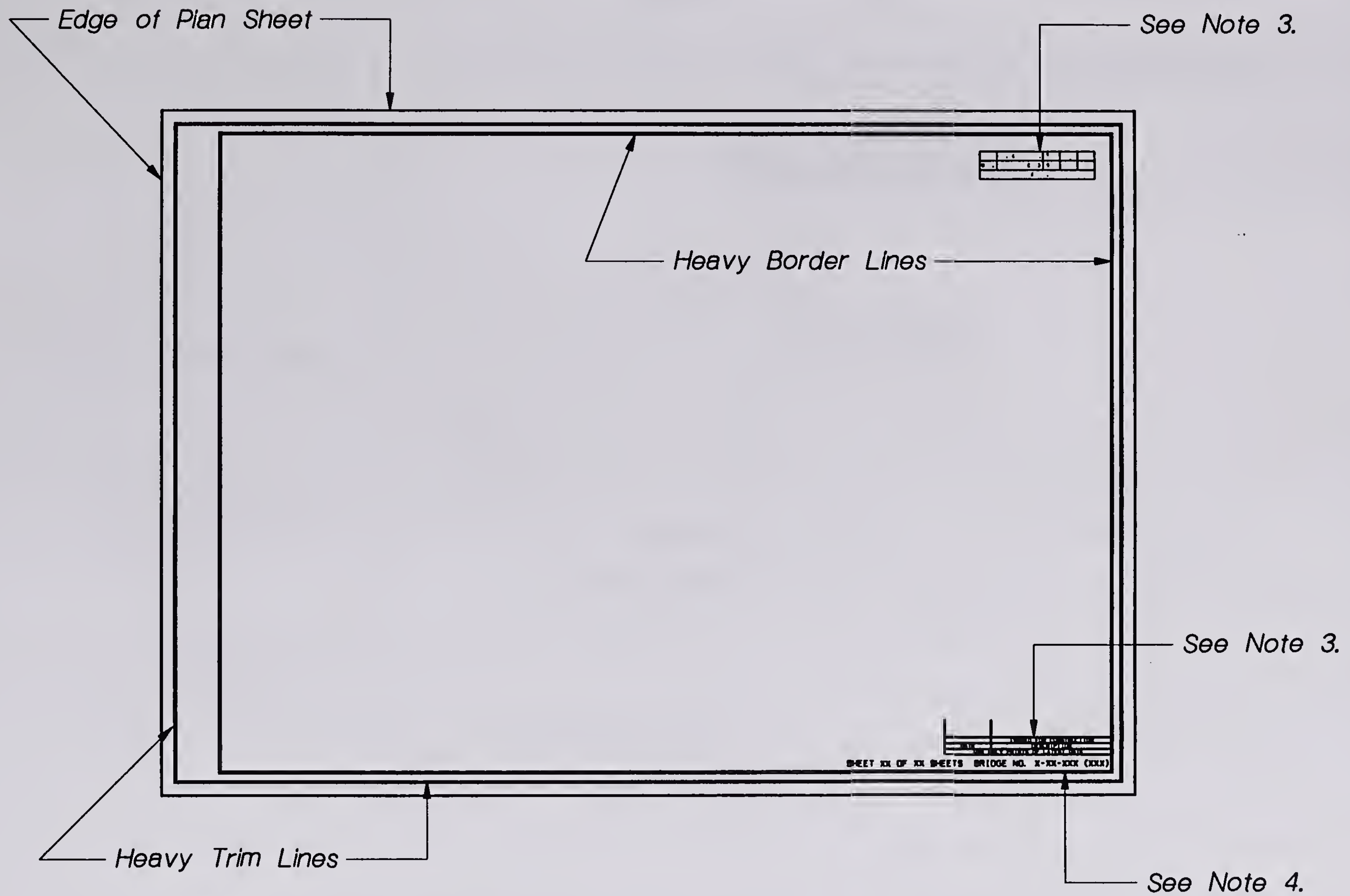
MASS HIGHWAY
BRIDGE
MANUAL

STANDARD FIRST SHEET

CONSTRUCTION PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.1.1



NOTES:

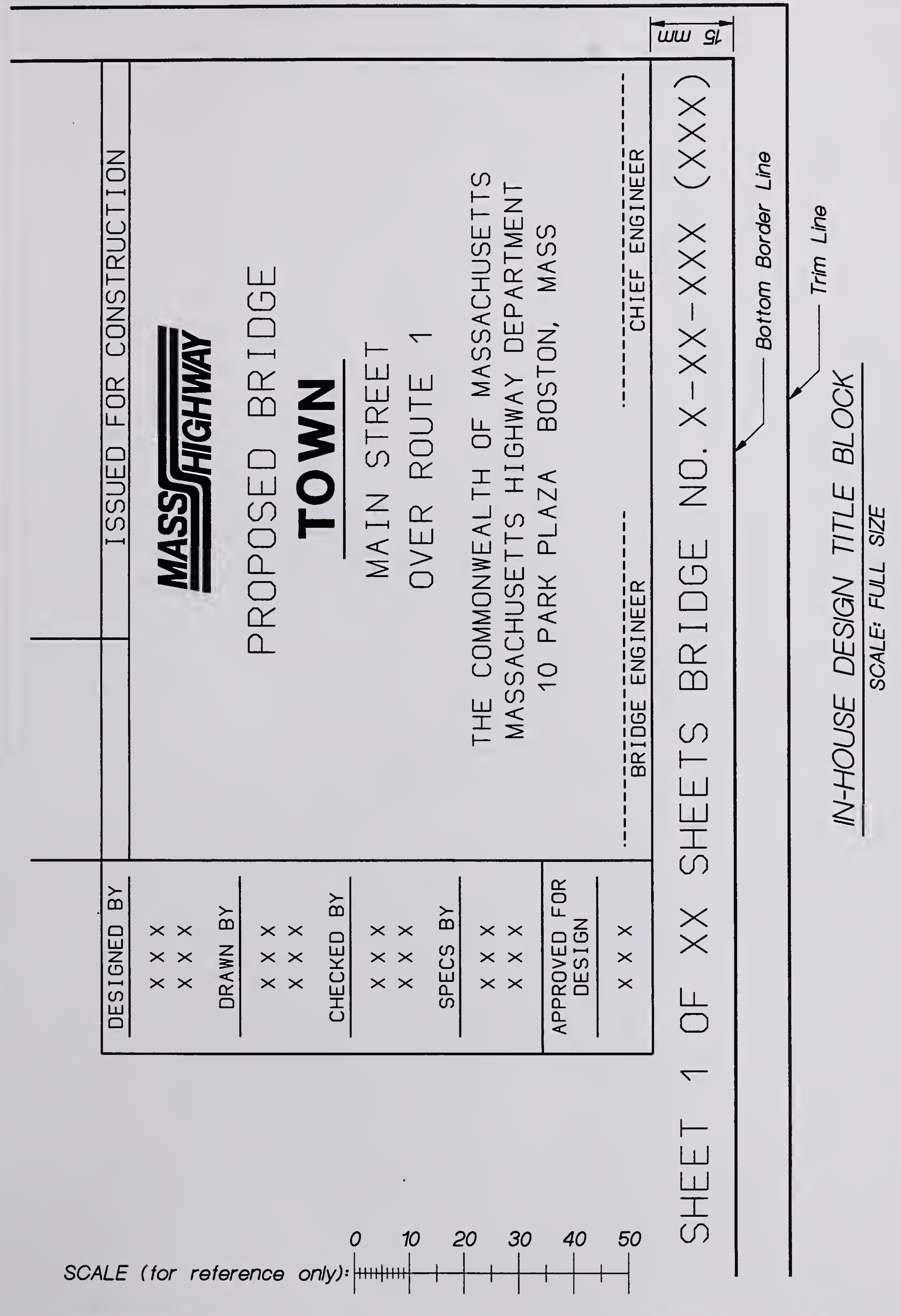
1. The above drawing is not drawn to scale.
2. The size and dimensions for subsequent sheets are the same as for the Standard First Sheet (see Dwg. No. 1.1.1).
3. See Dwg. No. 1.1.5 for the Federal Aid Block and for the Subsequent Sheets Title Block.
4. Bridge with single Bridge Identification Number (B.I.N.) shown. For bridges with multiple B.I.N.'s, see Dwg. No. 1.1.5.

MASS HIGHWAY
BRIDGE
MANUAL

STANDARD SUBSEQUENT SHEETS
CONSTRUCTION PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.1.2

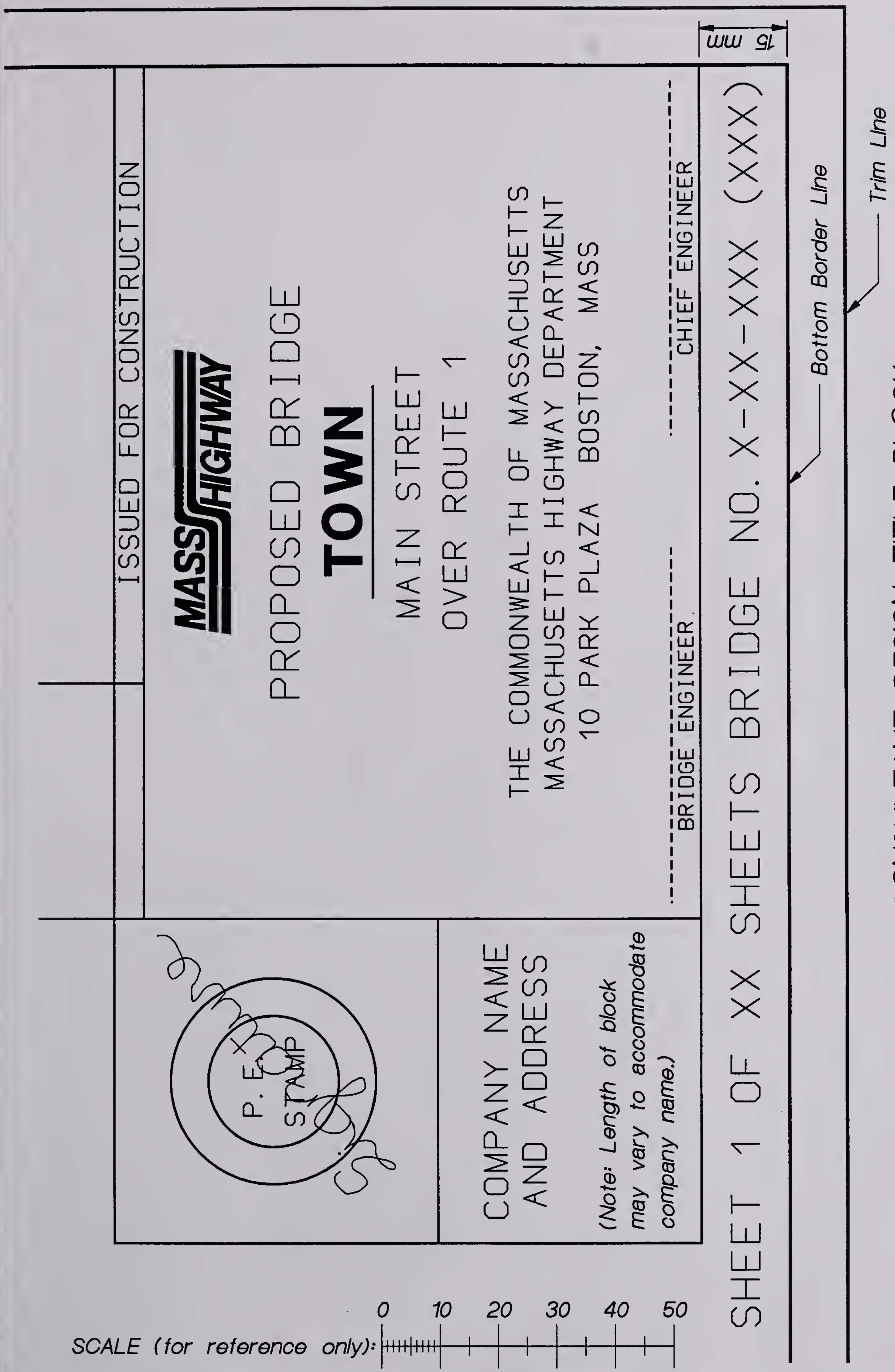


IN-HOUSE DESIGN TITLE BLOCK

SCALE: FULL SIZE

NOTE: For other types of construction projects, replace the "PROPOSED BRIDGE" title with the correct project description (for example, "PROPOSED BRIDGE REPAIRS" and "PROPOSED BRIDGE REHABILITATION"). The character size of the project description may have to be reduced to fit the longer titles.

MASS HIGHWAY BRIDGE MANUAL	IN-HOUSE DESIGN TITLE BLOCK CONSTRUCTION PLANS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **1.1.3**

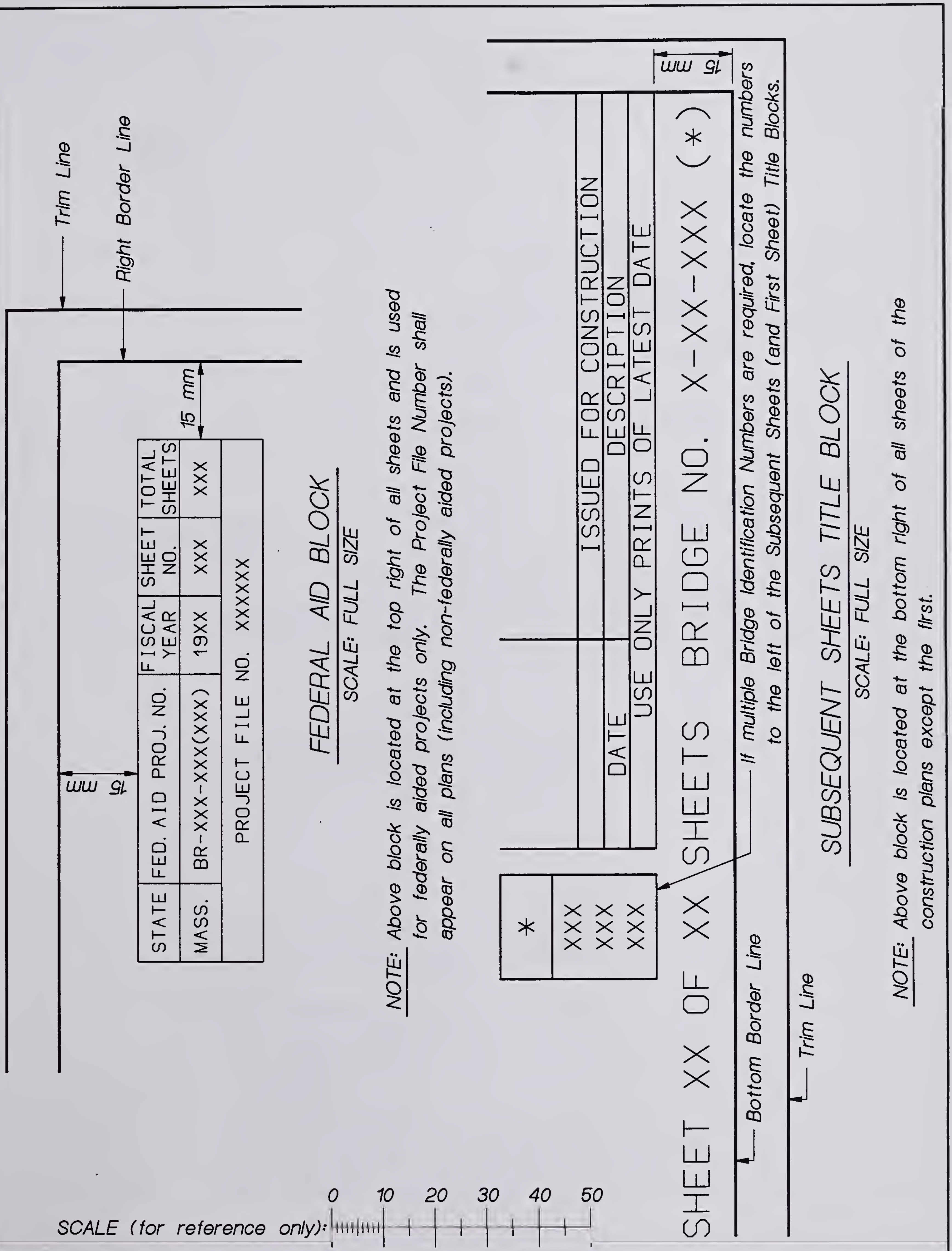

15 mm
ISSUED FOR CONSTRUCTION
MASS HIGHWAY
PROPOSED BRIDGE
TOWN
MAIN STREET
OVER ROUTE 1
THE COMMONWEALTH OF MASSACHUSETTS
MASSACHUSETTS HIGHWAY DEPARTMENT
10 PARK PLAZA BOSTON, MASS
BRIDGE ENGINEER
CHIEF ENGINEER
P. E. STAMP
COMPANY NAME
AND ADDRESS
(Note: Length of block may vary to accommodate company name.)
SHEET 1 OF XX SHEETS BRIDGE NO. X-XX-XXX (XXX)
Bottom Border Line
Trim Line
SCALE (for reference only):
0
10
20
30
40
50

CONSULTANT DESIGN TITLE BLOCK

SCALE: FULL SIZE

NOTE: For other types of construction projects, replace the "PROPOSED BRIDGE" title with the correct project description (for example, "PROPOSED BRIDGE REPAIRS" and "PROPOSED BRIDGE REHABILITATION"). The character size of the project description may have to be reduced to fit the longer titles.

CONSULTANT DESIGN TITLE BLOCK
CONSTRUCTION PLANS



FEDERAL AID BLOCK

SCALE: FULL SIZE

NOTE: Above block is located at the top right of all sheets and is used for federally aided projects only. The Project File Number shall appear on all plans (including non-federally aided projects).

If multiple Bridge Identification Numbers are required, locate the numbers to the left of the Subsequent Sheets (and First Sheet) Title Blocks.

SUBSEQUENT SHEETS TITLE BLOCK

SCALE: FULL SIZE

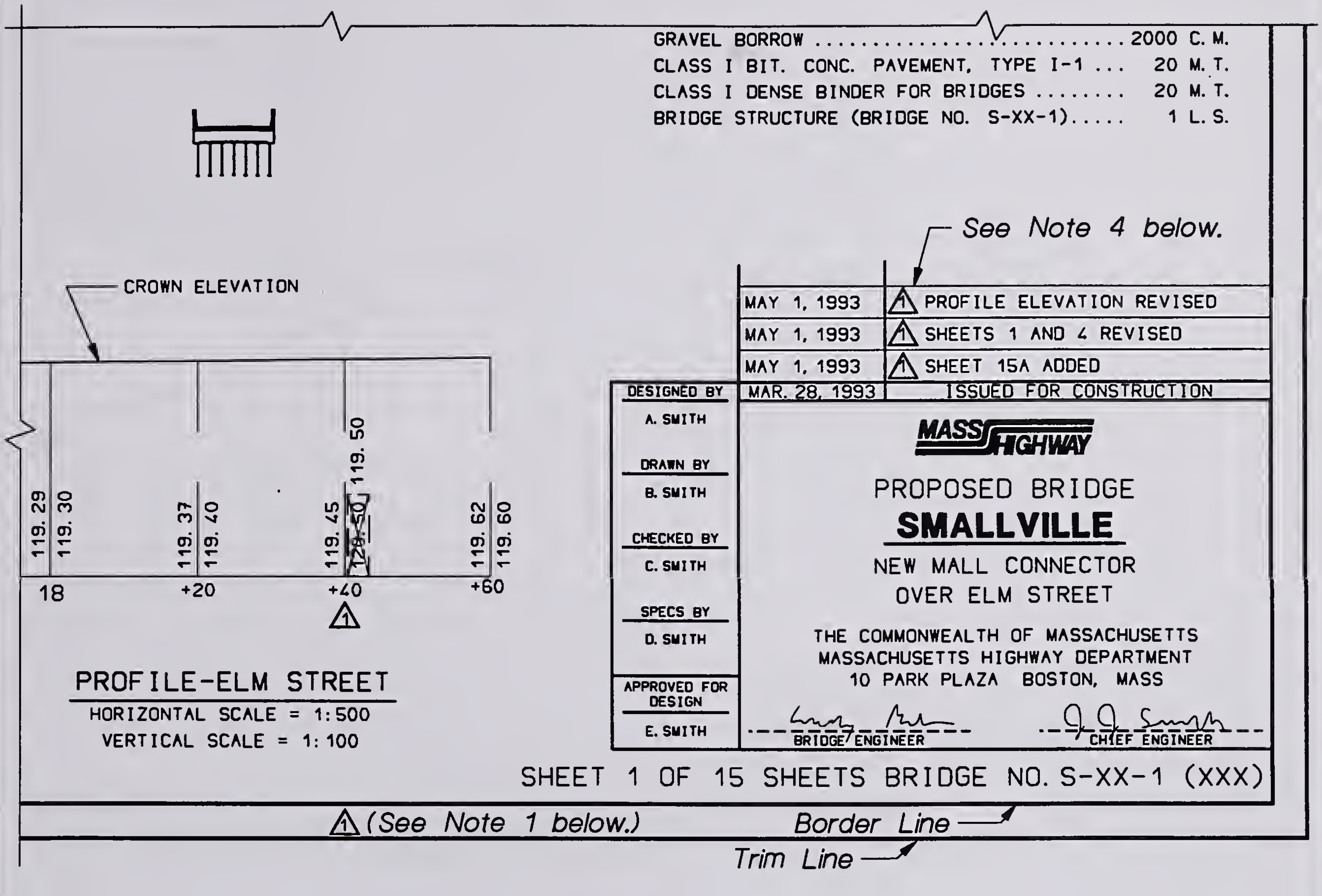
NOTE: Above block is located at the bottom right of all sheets of the construction plans except the first.

MASS HIGHWAY
BRIDGE MANUAL

MISCELLANEOUS BLOCKS
CONSTRUCTION PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.1.5



GRAVEL BORROW	2000 C. M.
CLASS I BIT. CONC. PAVEMENT, TYPE I-1	20 M. T.
CLASS I DENSE BINDER FOR BRIDGES	20 M. T.
BRIDGE STRUCTURE (BRIDGE NO. S-XX-1)	1 L. S.

PROFILE-ELM STREET
HORIZONTAL SCALE = 1:500
VERTICAL SCALE = 1:100

MAY 1, 1993	△1 PROFILE ELEVATION REVISED
MAY 1, 1993	△1 SHEETS 1 AND 4 REVISED
MAY 1, 1993	△1 SHEET 15A ADDED
MAR. 28, 1993	ISSUED FOR CONSTRUCTION

DESIGNED BY
A. SMITH
DRAWN BY
B. SMITH
CHECKED BY
C. SMITH
SPECS BY
D. SMITH
APPROVED FOR DESIGN
E. SMITH

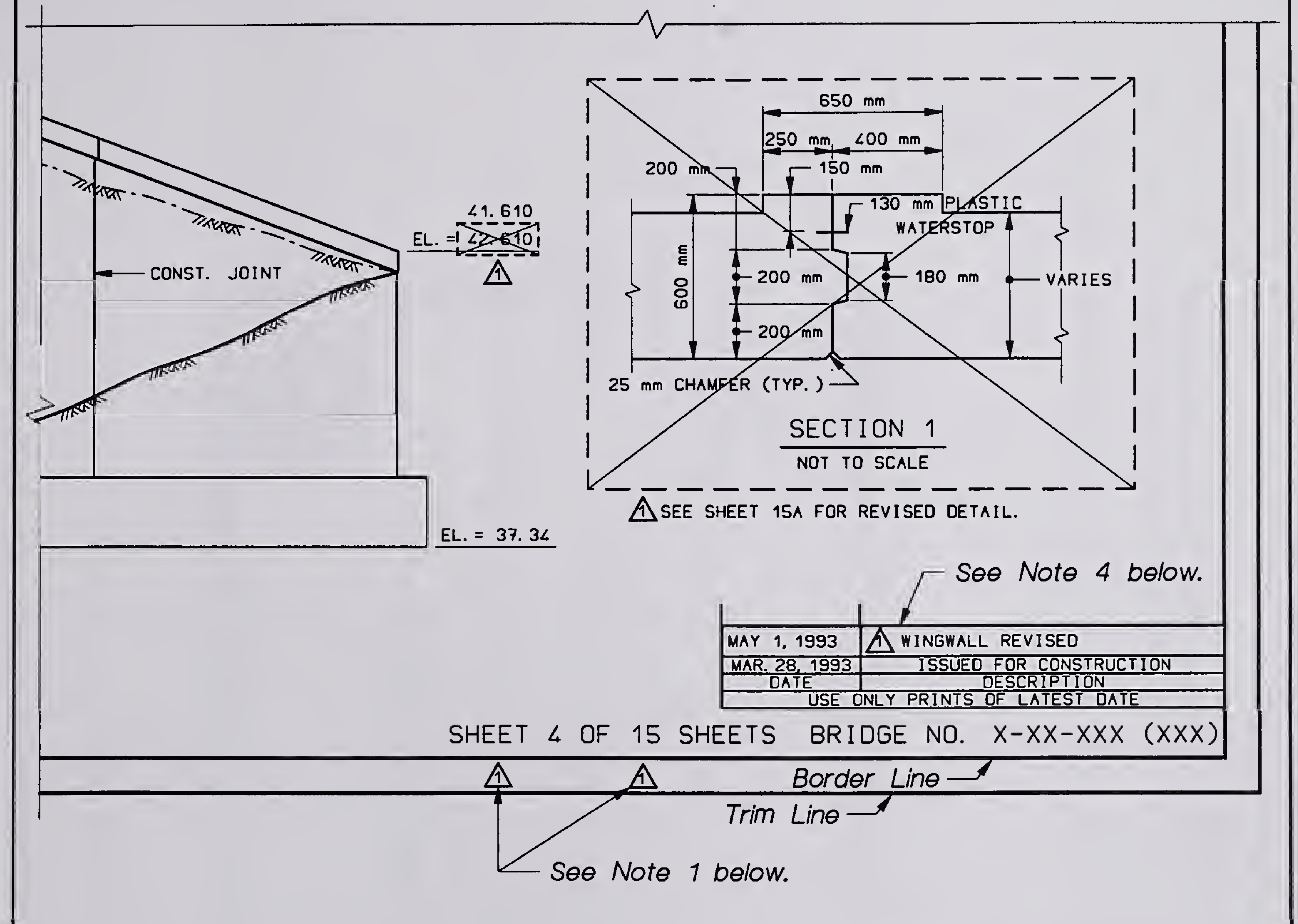
MASSHIGHWAY
PROPOSED BRIDGE
SMALLVILLE
NEW MALL CONNECTOR
OVER ELM STREET
THE COMMONWEALTH OF MASSACHUSETTS
MASSACHUSETTS HIGHWAY DEPARTMENT
10 PARK PLAZA BOSTON, MASS
BRIDGE ENGINEER
CHIEF ENGINEER

SHEET 1 OF 15 SHEETS BRIDGE NO. S-XX-1 (XXX)

FIRST SHEET OF CONSTRUCTION PLANS
NOT TO SCALE

NOTES:

1. *Revision symbols (△) may be located in the lower, upper or right hand margin to facilitate locating revisions.*
2. *Revisions made on the same date shall have the same number in the revision symbol.*
3. *When revising the construction plans, erasures are not permitted.*
4. *Indicate the sheet numbers of all revised and/or added sheets over the title block. If there are any revisions on the first sheet, provide a description of the revisions as well.*



TYP. SUBSEQUENT SHEET OF CONSTRUCTION PLANS

NOT TO SCALE

NOTES:

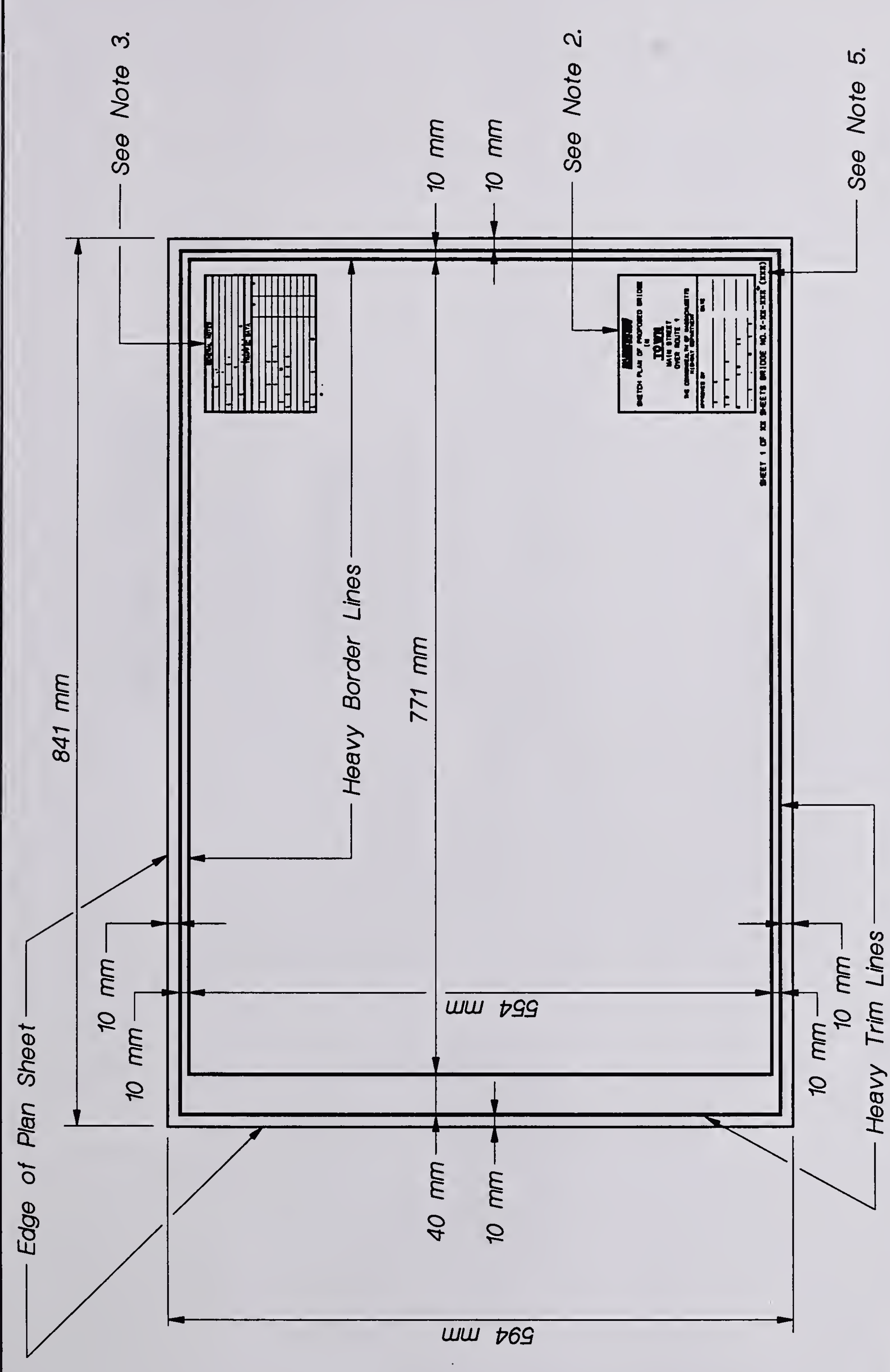
1. *Revision symbols (△) may be located in the lower, upper or right hand margin to facilitate locating revisions.*
2. *Revisions made on the same date shall have the same number in the revision symbol.*
3. *When revising the construction plans, erasures are not permitted.*
4. *Provide a description of the revisions over the subsequent sheet title block. Indicate the sheet number of all revised and/or added sheets over the first sheet title block (see Dwg. No. 1.1.6).*

MASS HIGHWAY
BRIDGE
MANUAL

REVISIONS TO SUBSEQUENT SHEETS
CONSTRUCTION PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.1.7



NOTES:

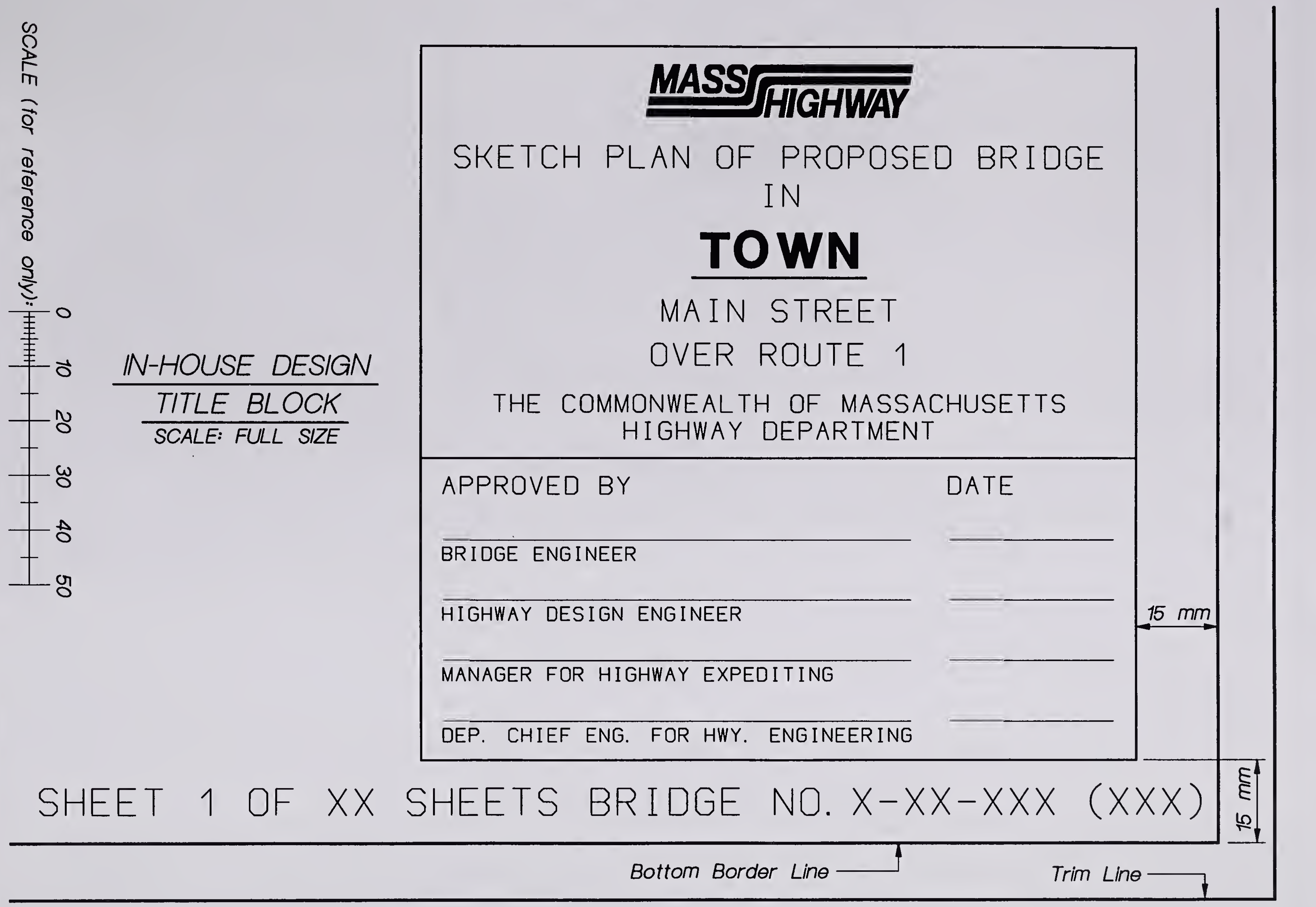
1. The above drawing is not drawn to scale.
2. See Dwg. No. 1.2.2 for the In-House Design Title Block or Dwg. No. 1.2.3 for the Consultant Design Title Block.
3. See Dwg. No. 1.2.4 for the Standard Data Block.
4. Subsequent Sheets are the same size and dimension as the first sheet. Omit Data Block and Title Block on subsequent sheets. Retain sheet and Bridge Numbers at bottom right corner of all sheets.
5. For bridges with multiple Bridge Identification Numbers, locate numbers in a box to the left of the Title Block (or above the Bridge Number on subsequent sheets) similar to Dwg. No. 1.1.5.

MASSHIGHWAY BRIDGE MANUAL	STANDARD FIRST SHEET SKETCH PLANS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **1.2.1**

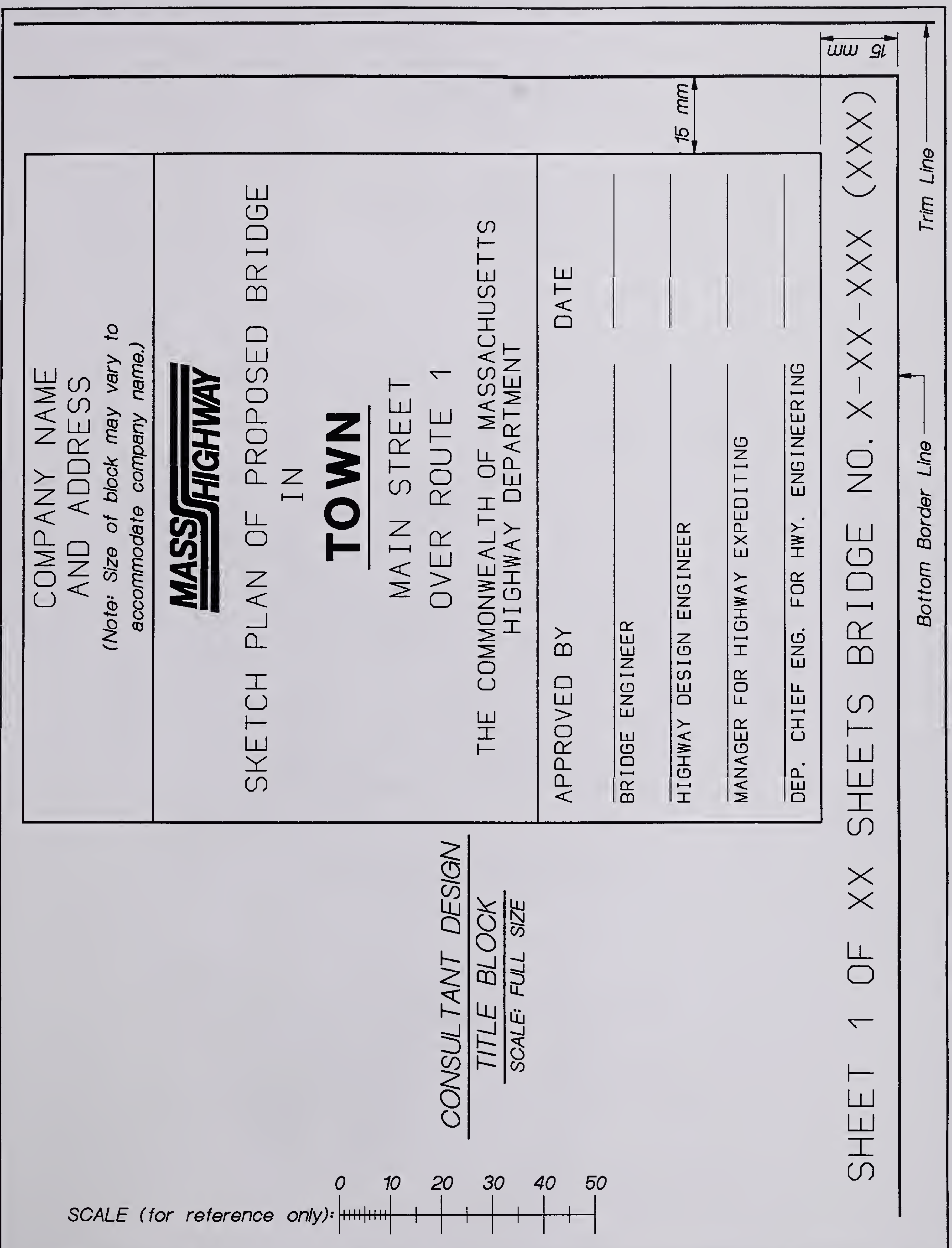
IN-HOUSE DESIGN
TITLE BLOCK
SKETCH PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.2.2


SCALE (for reference only):
0
10
20
30
40
50
MASS HIGHWAY
SKETCH PLAN OF PROPOSED BRIDGE
IN
TOWN
MAIN STREET
OVER ROUTE 1
THE COMMONWEALTH OF MASSACHUSETTS
HIGHWAY DEPARTMENT
APPROVED BY
DATE
BRIDGE ENGINEER
HIGHWAY DESIGN ENGINEER
MANAGER FOR HIGHWAY EXPEDITING
DEP. CHIEF ENG. FOR HWY. ENGINEERING
15 mm
SHEET 1 OF XX SHEETS BRIDGE NO. X-XX-XXX (XXX)
15 mm
Bottom Border Line
Trim Line

IN-HOUSE DESIGN
TITLE BLOCK
SCALE: FULL SIZE


COMPANY NAME
AND ADDRESS
(Note: Size of block may vary to
accommodate company name.)
MASS HIGHWAY
SKETCH PLAN OF PROPOSED BRIDGE
IN
TOWN
MAIN STREET
OVER ROUTE 1
THE COMMONWEALTH OF MASSACHUSETTS
HIGHWAY DEPARTMENT
APPROVED BY
DATE
BRIDGE ENGINEER
HIGHWAY DESIGN ENGINEER
MANAGER FOR HIGHWAY EXPEDITING
DEP. CHIEF ENG. FOR HWY. ENGINEERING
SHEET 1 OF XX SHEETS BRIDGE NO. X-XX-XXX (XXX)
15 mm
15 mm
Trim Line
Bottom Border Line
CONSULTANT DESIGN
TITLE BLOCK
SCALE: FULL SIZE
SCALE (for reference only):
0
10
20
30
40
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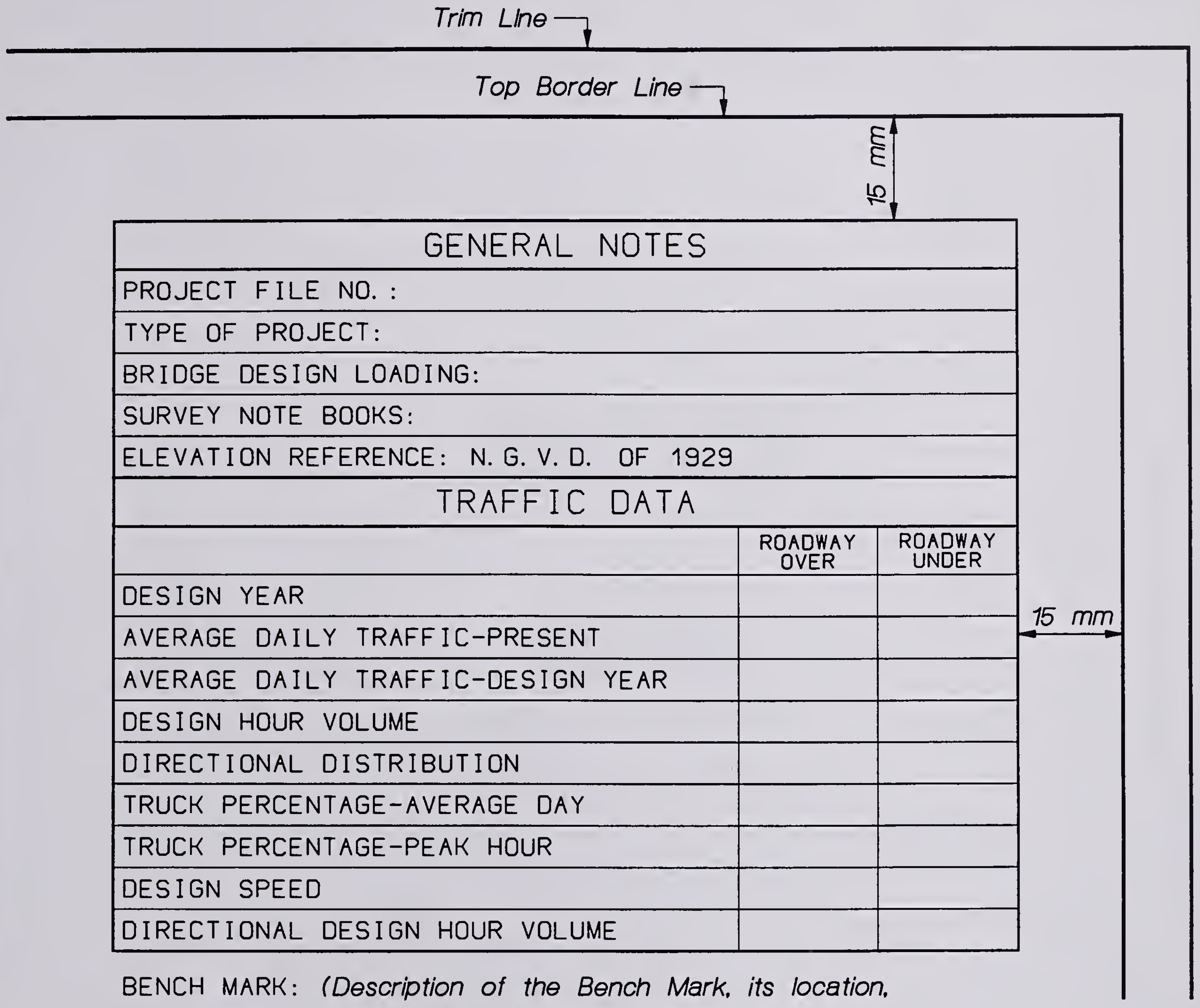
MASS HIGHWAY
BRIDGE
MANUAL

CONSULTANT DESIGN
TITLE BLOCK
SKETCH PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.2.3



GENERAL NOTES		
PROJECT FILE NO. :		
TYPE OF PROJECT:		
BRIDGE DESIGN LOADING:		
SURVEY NOTE BOOKS:		
ELEVATION REFERENCE: N. G. V. D. OF 1929		
TRAFFIC DATA		
	ROADWAY OVER	ROADWAY UNDER
DESIGN YEAR		
AVERAGE DAILY TRAFFIC-PRESENT		
AVERAGE DAILY TRAFFIC-DESIGN YEAR		
DESIGN HOUR VOLUME		
DIRECTIONAL DISTRIBUTION		
TRUCK PERCENTAGE-AVERAGE DAY		
TRUCK PERCENTAGE-PEAK HOUR		
DESIGN SPEED		
DIRECTIONAL DESIGN HOUR VOLUME		

BENCH MARK: *(Description of the Bench Mark, its location, and its elevation to be noted here.)*

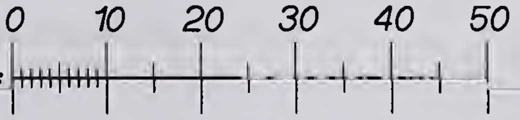
STANDARD DATA BLOCK

SCALE: FULL SIZE

NOTES:

1. *If any of the information in the above blocks is unknown or is not available then note "N/A" in the space provided.*
2. *If there will not be a road under the proposed bridge then draw an "X" over the column labeled "ROADWAY UNDER".*

SCALE (for reference only):

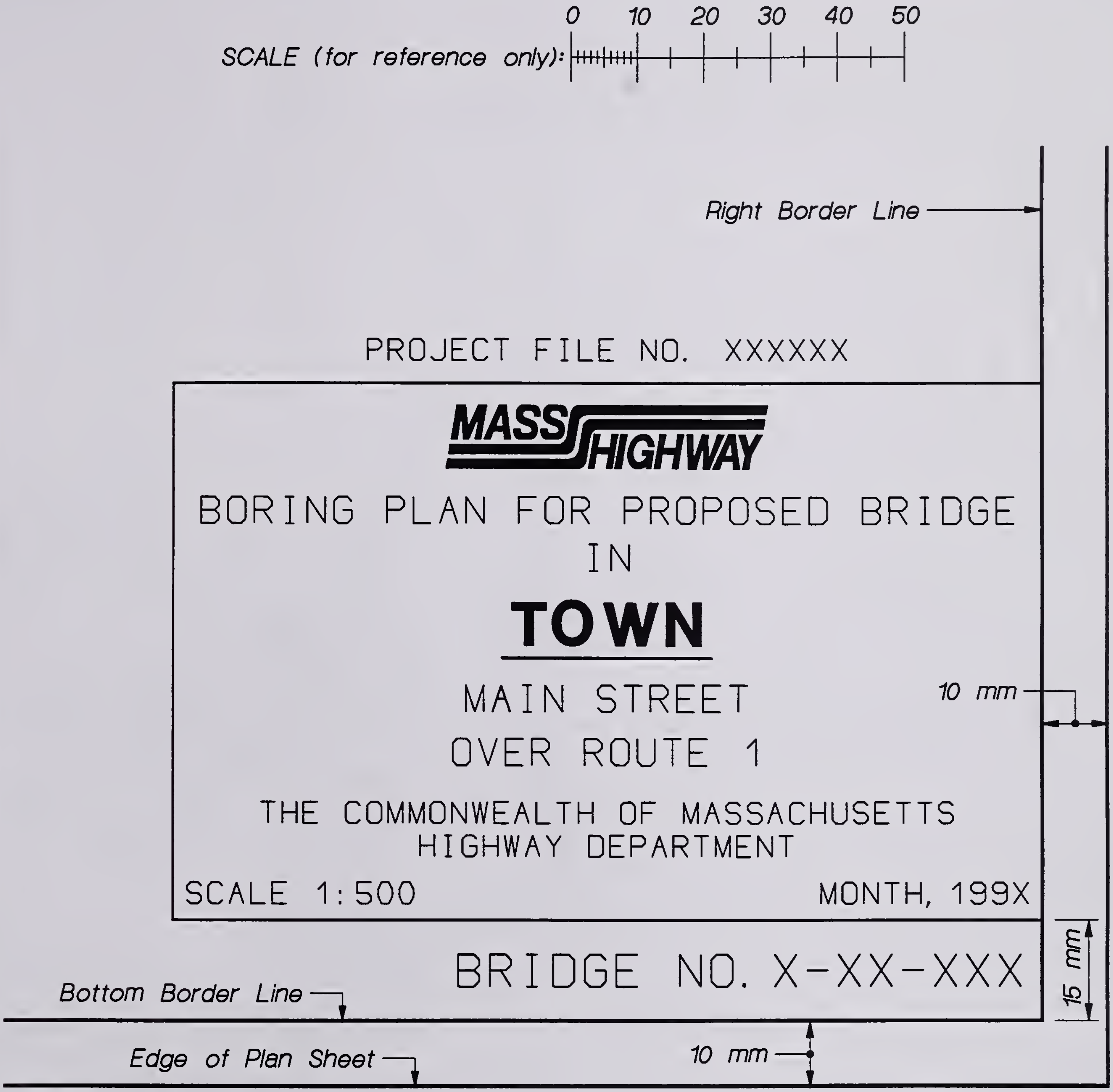


MASS HIGHWAY
BRIDGE
MANUAL

STANDARD DATA BLOCK
SKETCH PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.2.4



TITLE BLOCK

SCALE: FULL SIZE

NOTE:

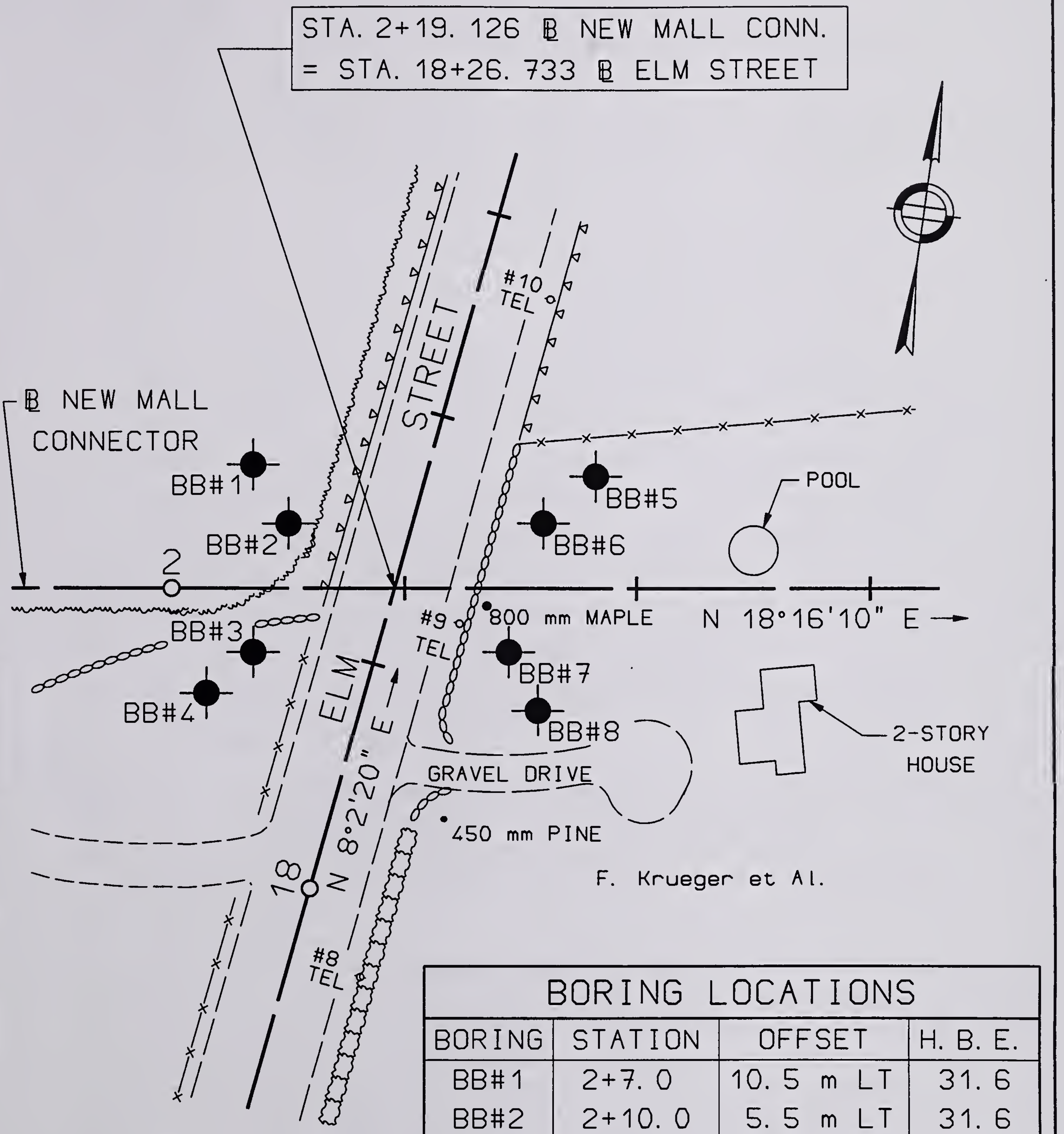
Size of Boring Plans may vary to accomodate the plan view, boring locations, and notes. However, the maximum size should not exceed the size of the standard construction plans shown on Dwg. No. 1.1.1.

MASS HIGHWAY
BRIDGE
MANUAL

STANDARD TITLE BLOCK
BORING PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.3.1



BORING LOCATIONS

BORING	STATION	OFFSET	H. B. E.
BB#1	2+7. 0	10. 5 m LT	31. 6
BB#2	2+10. 0	5. 5 m LT	31. 6
BB#3	2+7. 0	5. 5 m RT	31. 6
BB#4	2+3. 0	9. 0 m RT	31. 6
BB#5	2+36. 5	9. 5 m LT	28. 2
BB#6	2+32. 0	5. 5 m LT	28. 2
BB#7	2+29. 0	5. 5 m RT	28. 2
BB#8	2+31. 5	10. 5 m RT	28. 2

NOTE:

Above drawing is drawn to a scale of 1:500.

MASS HIGHWAY
BRIDGE MANUAL

SAMPLE PLAN
BORING PLANS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
1.3.2

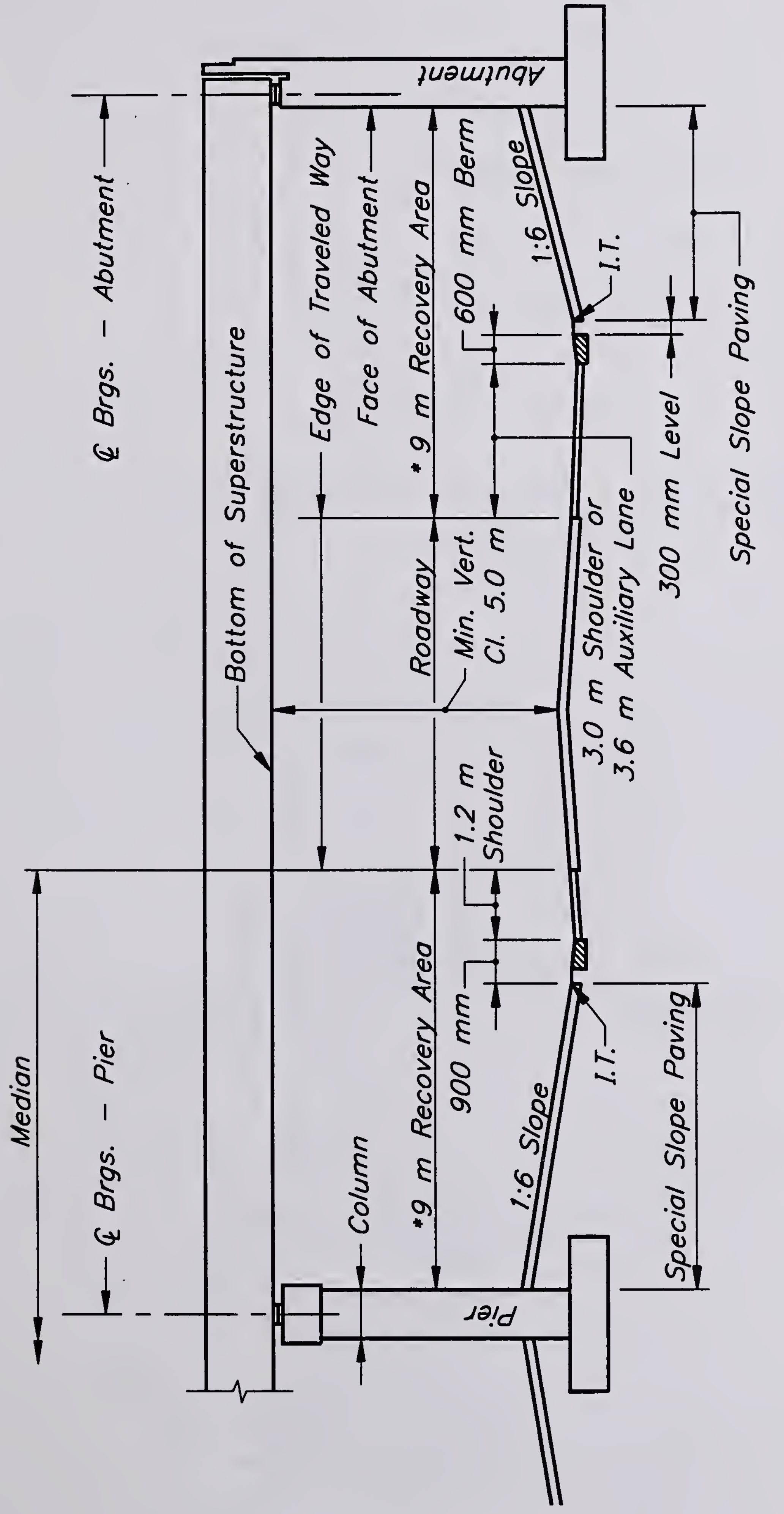
NOTES:

1. LOCATION OF DRIVE SAMPLE BORINGS ARE SHOWN THUS: ● *(See Notes 1 and 2 below.)*
2. SEE THE BORING LOCATIONS TABLE FOR THE SPECIFIED HIGHEST BOTTOM ELEVATION (H. B. E.) OF EACH BORING. *(See Note 3 below.)*
3. BORINGS SHALL EXTEND TO THE SPECIFIED HIGHEST BOTTOM ELEVATION OR TO REFUSAL BELOW THE H. B. E., WHICHEVER IS DEEPER. *(See Note 4 below.)*
4. SHOULD BEDROCK BE ENCOUNTERED AT OR ABOVE THE SPECIFIED HIGHEST BOTTOM ELEVATION, THE BORING SHALL BE CONTINUED AS A ROCK CORE BORING FOR A DEPTH OF 3 m THEN TERMINATED. *(See Note 5 below.)*
5. BENCH MARK: *(Description of the Bench Mark, its location, and its elevation to be noted here.)*
6. BORINGS ARE LOCATED FROM THE BASELINE OF THE NEW MALL CONNECTOR. *(Edit as required.)*
7. ADDITIONAL BORINGS MAY BE REQUESTED BY THE ENGINEER IF NECESSARY.

NOTES:

1. *The type of subsurface investigation shall be determined by the designer and shall be proper for the site conditions and the type of the proposed bridge. (Refer to the latest edition of the AASHTO Manual on Subsurface Investigations.)*
2. *If complimentary borings are required, then the boring locations shall be shown thus:* ● *(Control)*
   ○ *(Complimentary)*
3. *The specified highest bottom elevation (H.B.E.) shall be determined by the designer and shall be adequate to assess the foundation bearing capacity and settlement in conformance with the latest edition of the AASHTO Standard Specifications for Highway Bridges.*
4. *Where accurate information of the proposed bridge site indicates that refusal occurs far below the H.B.E., the designer may consider reducing the number of borings which extend to refusal depending on the complexity of the proposed structure. However, at least one boring shall extend deeper than the H.B.E. to refusal.*
5. *For the depth of rock core borings at drilled shaft locations, refer to the latest edition of the AASHTO Standard Specifications for Highway Bridges. Specify on the plans a minimum of a 50 mm diameter NX rock core to be taken at drilled shaft locations socketed into rock.*
6. *For wall structures, boring locations are shown thus:* ● WB#1
7. *Testpits are shown thus:* ◩
8. *Observation wells are shown thus:* ⊽ OW

MASS HIGHWAY BRIDGE MANUAL	BORING REQUEST NOTES BORING PLANS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **1.3.3**



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. * If an additional lane is anticipated in Recovery Area, set bottom of footing to provide sufficient cover for future use.
2. Show all dimensions on Sketch Plans and Construction Drawings.

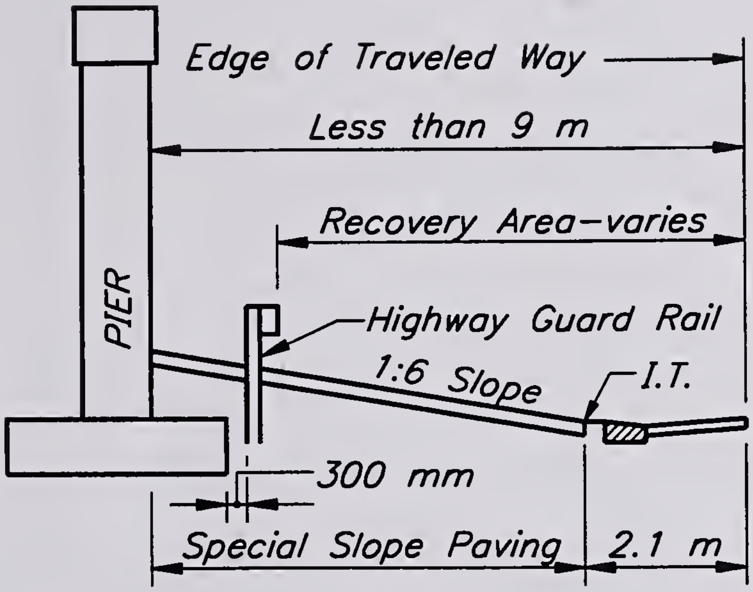
Plot Scale = 1:150

MASS HIGHWAY
BRIDGE MANUAL

LIMITED ACCESS HIGHWAY
(9 m RECOVERY AREA)
CLEARANCES UNDER BRIDGE

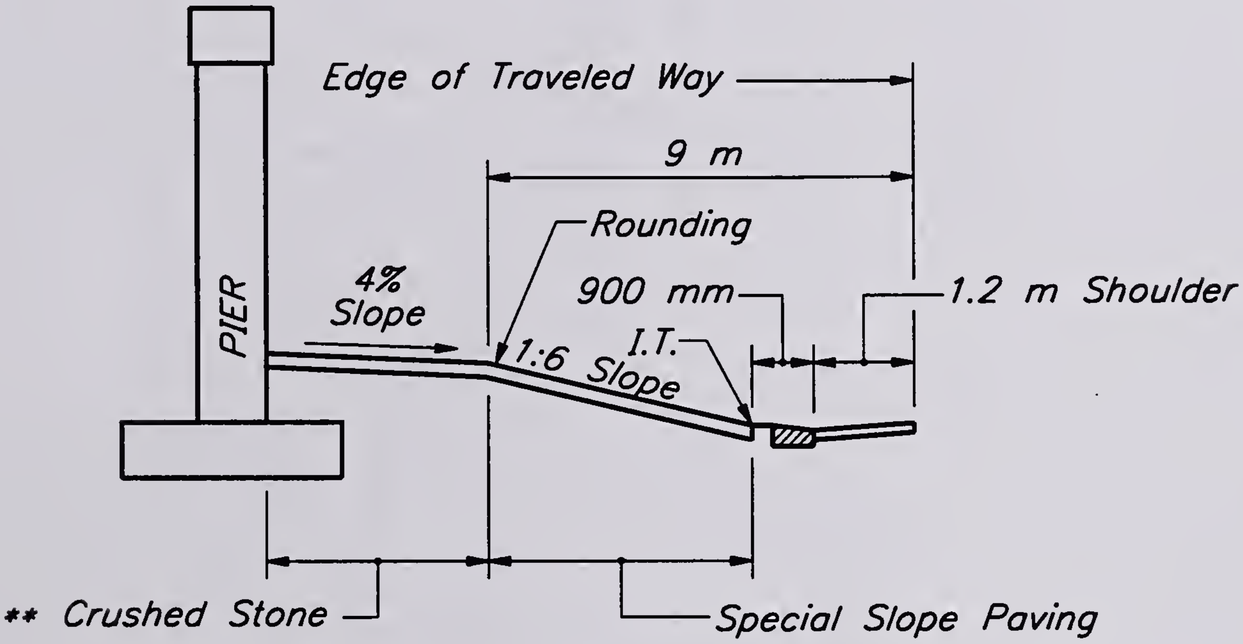
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.1



PIER WITHIN STANDARD RECOVERY AREA

NOT TO SCALE



PIER OUTSIDE OF RECOVERY AREA

NOT TO SCALE

NOTES:

1. ** 100 mm Cement Concrete over 150 mm Gravel is to be substituted for the above in urban areas and locations that may be accessible to pedestrians.
2. Show all dimensions on Sketch Plans and Construction Drawings.

Plot Scale = 1:200

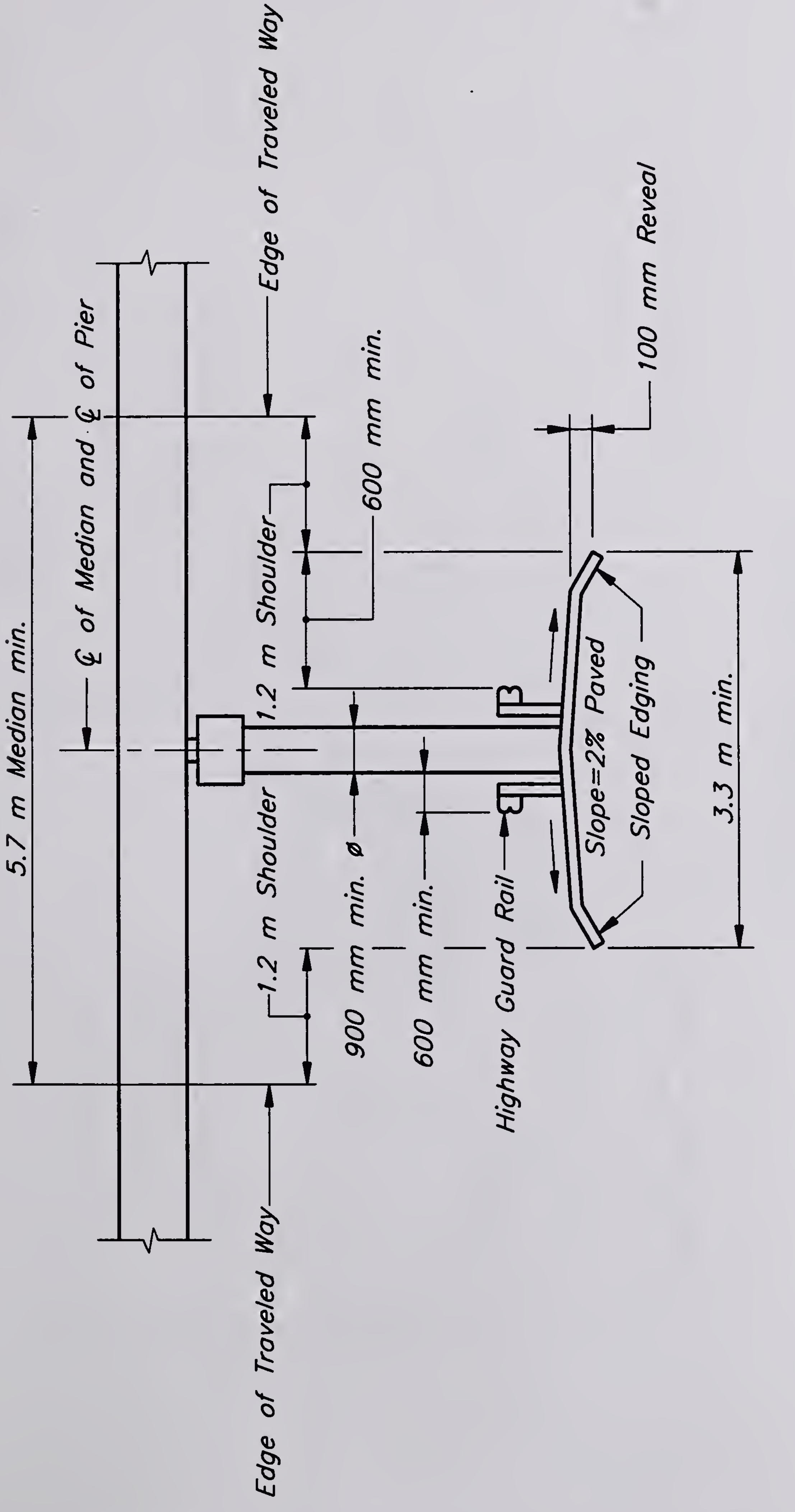
MASS HIGHWAY
BRIDGE
MANUAL

LIMITED ACCESS HIGHWAY
(NONSTANDARD RECOVERY AREA)
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.2

Plot Scale = 1:30



LONGITUDINAL SECTION

NOT TO SCALE

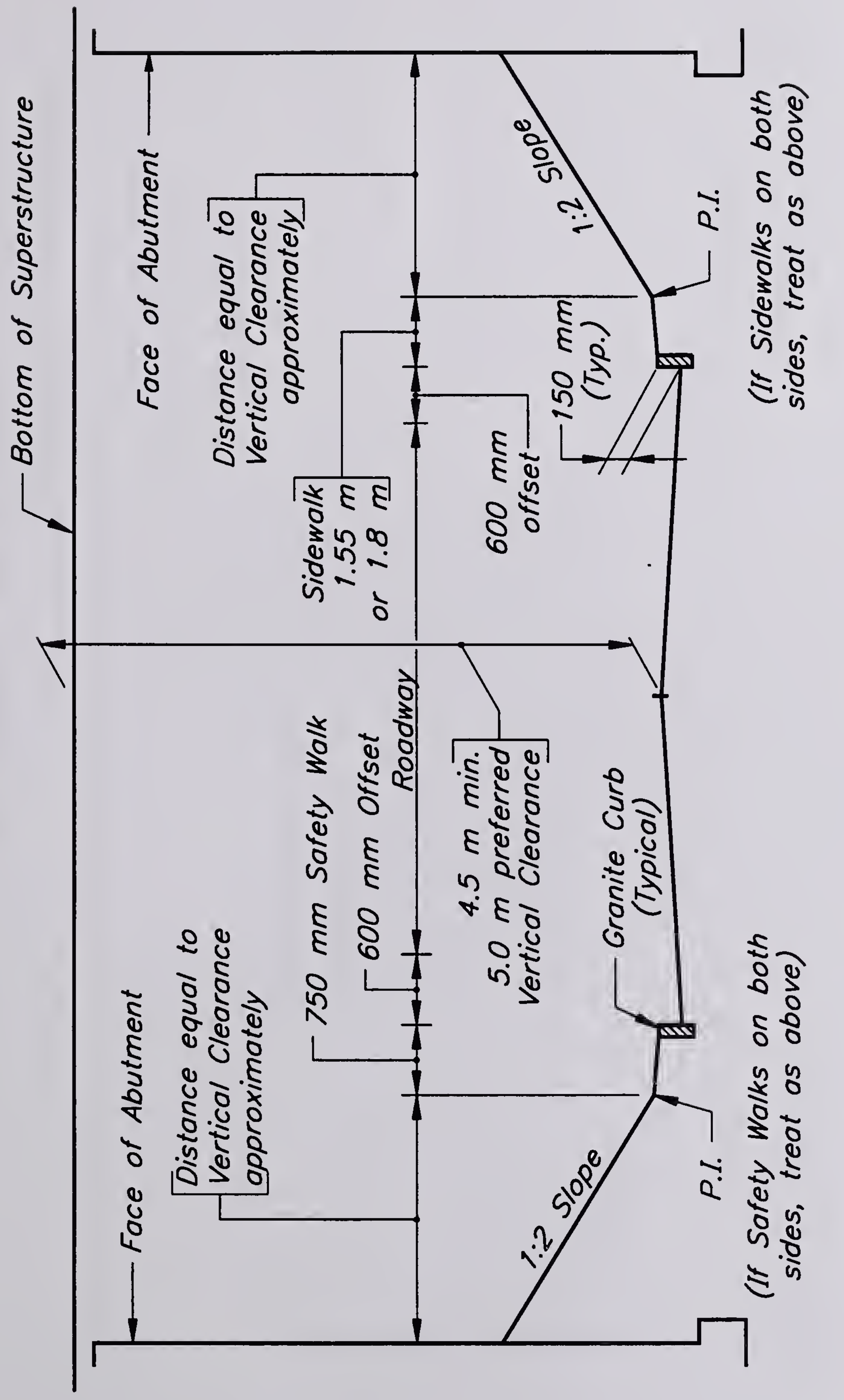
NOTES:
1. Provide openings in footing of pier for guard rail posts.
2. All dimensions are for square section.
3. Show all dimensions on Sketch Plans and Construction Drawings.

MASS HIGHWAY
BRIDGE
MANUAL

MINIMUM LATERAL CLEARANCES
AT PIER
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.3


Bottom of Superstructure
Face of Abutment
Distance equal to Vertical Clearance approximately
Sidewalk 1.55 m or 1.8 m
600 mm offset
150 mm (Typ.)
1:2 Slope
P.I.
(If Sidewalks on both sides, treat as above)
750 mm Safety Walk
600 mm Offset
Roadway
4.5 m min. 5.0 m preferred Vertical Clearance
Granite Curb (Typical)
Face of Abutment
Distance equal to Vertical Clearance approximately
1:2 Slope
P.I.
(If Safety Walks on both sides, treat as above)

LONGITUDINAL SECTION

NOT TO SCALE

NOTE: Show all dimensions on Sketch Plans and Construction Drawings.

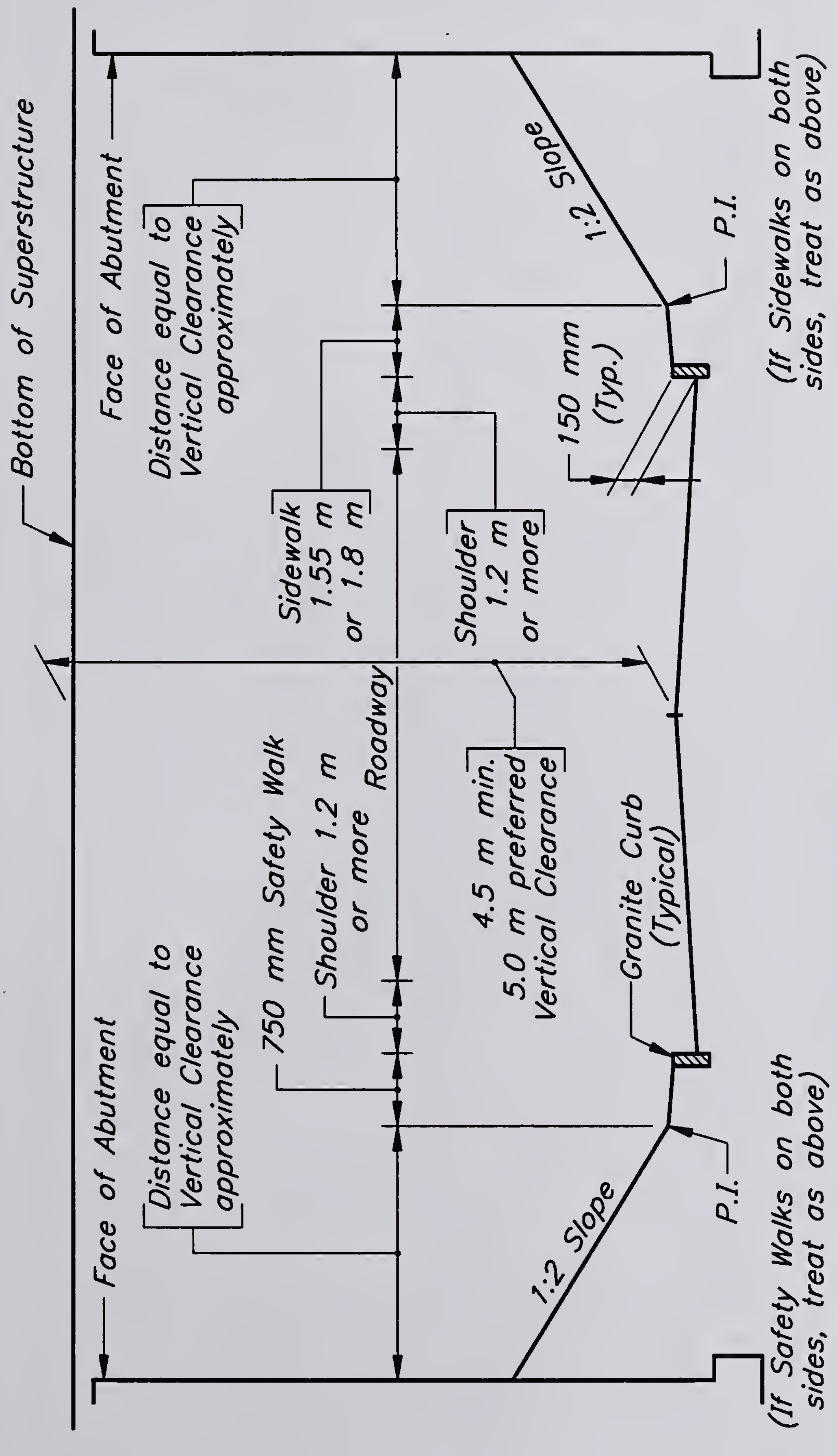
Plot Scale = 1:80

MASS HIGHWAY
BRIDGE
MANUAL

LOCAL ROAD
(WITHOUT SHOULDERS)
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.4


Bottom of Superstructure
Face of Abutment
Distance equal to Vertical Clearance approximately
Sidewalk 1.55 m or 1.8 m
Shoulder 1.2 m or more
1:2 Slope
P.I.
150 mm (Typ.)
(If Sidewalks on both sides, treat as above)
750 mm Safety Walk
Shoulder 1.2 m or more
Roadway
4.5 m min. 5.0 m preferred Vertical Clearance
Granite Curb (Typical)
Face of Abutment
Distance equal to Vertical Clearance approximately
1:2 Slope
P.I.
(If Safety Walks on both sides, treat as above)

LONGITUDINAL SECTION

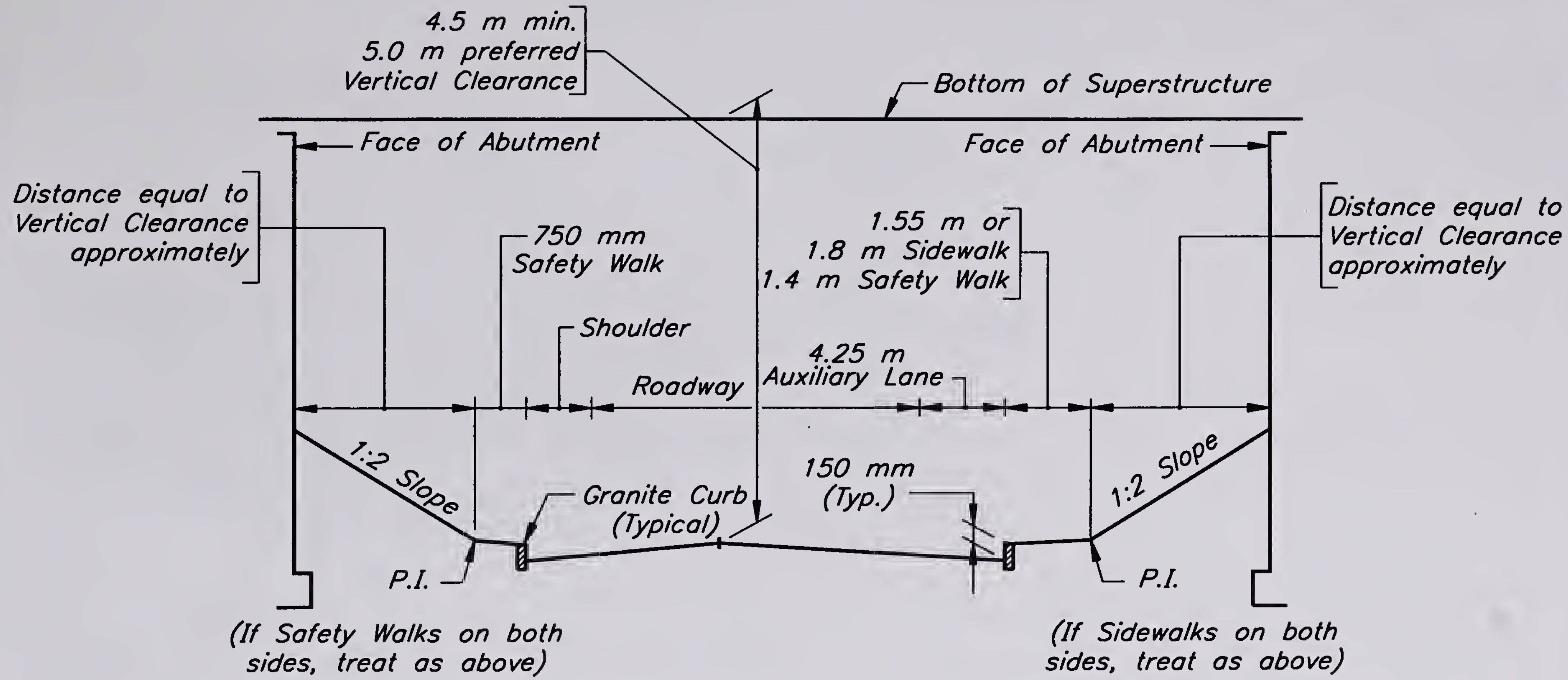
NOT TO SCALE

NOTE: Show all dimensions on Sketch Plans and Construction Drawings.

Plot Scale = 1:80

MASS HIGHWAY BRIDGE MANUAL	LOCAL ROAD (WITH SHOULDERS) CLEARANCES UNDER BRIDGE	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **2.1.5**

Plot Scale = 1:100



LONGITUDINAL SECTION
NOT TO SCALE

NOTE: Show all dimensions on Sketch Plans and Construction Drawings.

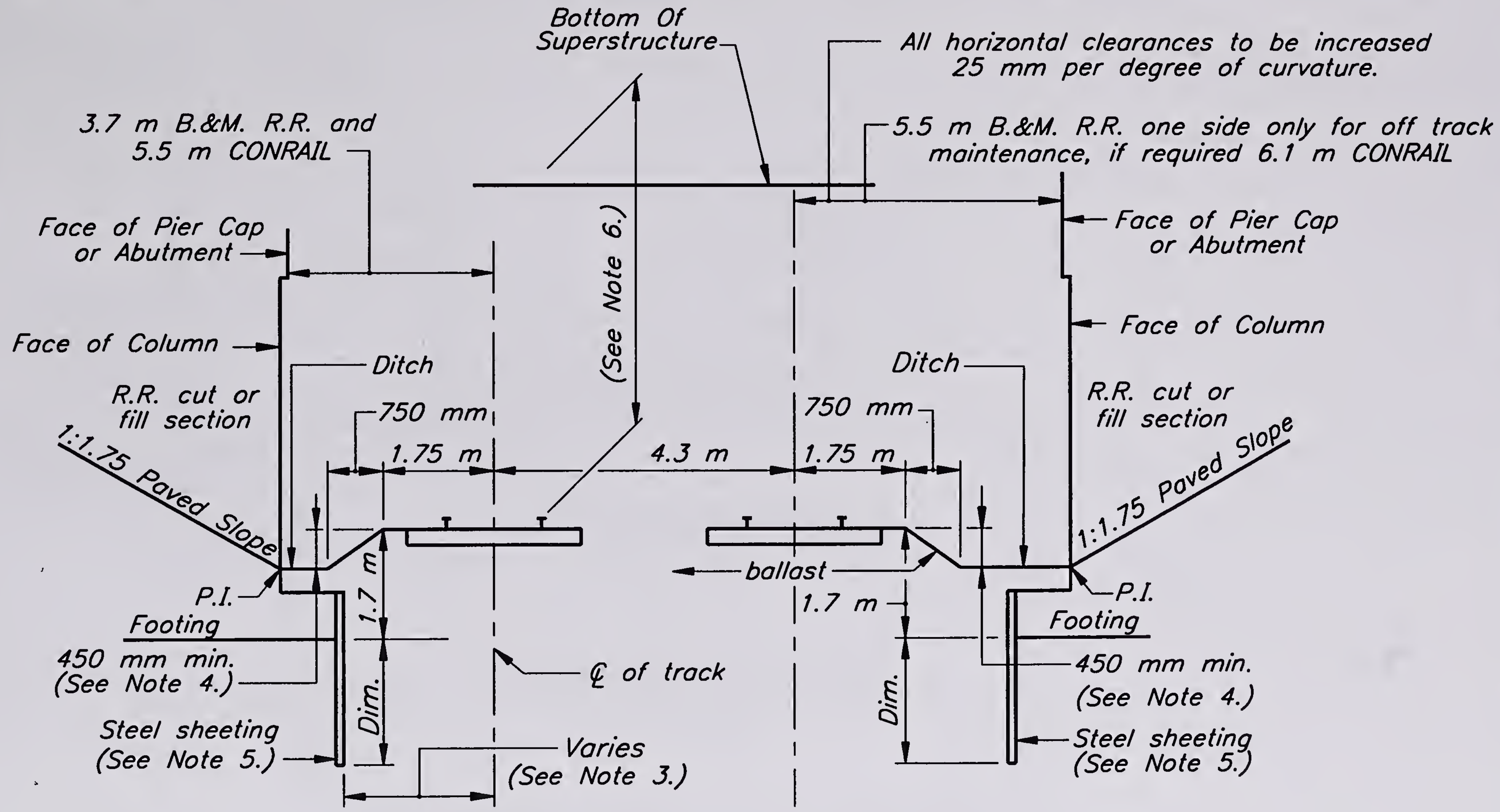
MASS HIGHWAY
BRIDGE
MANUAL

LOCAL ROAD
(WITH AUXILIARY LANE)
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.6

Plot Scale = 1:90


Bottom Of Superstructure
All horizontal clearances to be increased 25 mm per degree of curvature.
3.7 m B.&M. R.R. and 5.5 m CONRAIL
5.5 m B.&M. R.R. one side only for off track maintenance, if required 6.1 m CONRAIL
Face of Pier Cap or Abutment
Face of Pier Cap or Abutment
(See Note 6.)
Face of Column
Face of Column
Ditch
Ditch
R.R. cut or fill section
R.R. cut or fill section
750 mm
750 mm
1.75 m
4.3 m
1.75 m
1:1.75 Paved Slope
1:1.75 Paved Slope
ballast
1.7 m
1.7 m
P.I.
P.I.
Footing
Footing
450 mm min. (See Note 4.)
450 mm min. (See Note 4.)
℄ of track
Dim.
Dim.
Steel sheeting (See Note 5.)
Steel sheeting (See Note 5.)
Varies (See Note 3.)

LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. The clearances shown are for guide purposes and are subject to R.R. approval.
2. Single track R.R. lines are to be treated similarly.
3. Minimum distance from footing to ℄ main line track is 2.6 m for Boston & Maine R.R. or 2.3 m for other railroads. The footing to ℄ of spur and local line track is 2.3 m for Boston & Maine R.R. or 1.8 m for other railroads.
4. Survey the existing ditch so that the grade of the proposed ditch under bridge matches.
5. See Dwg. No. 2.1.8 for sheeting details and requirements.
6. For vertical clearance, consult Bridge Section.

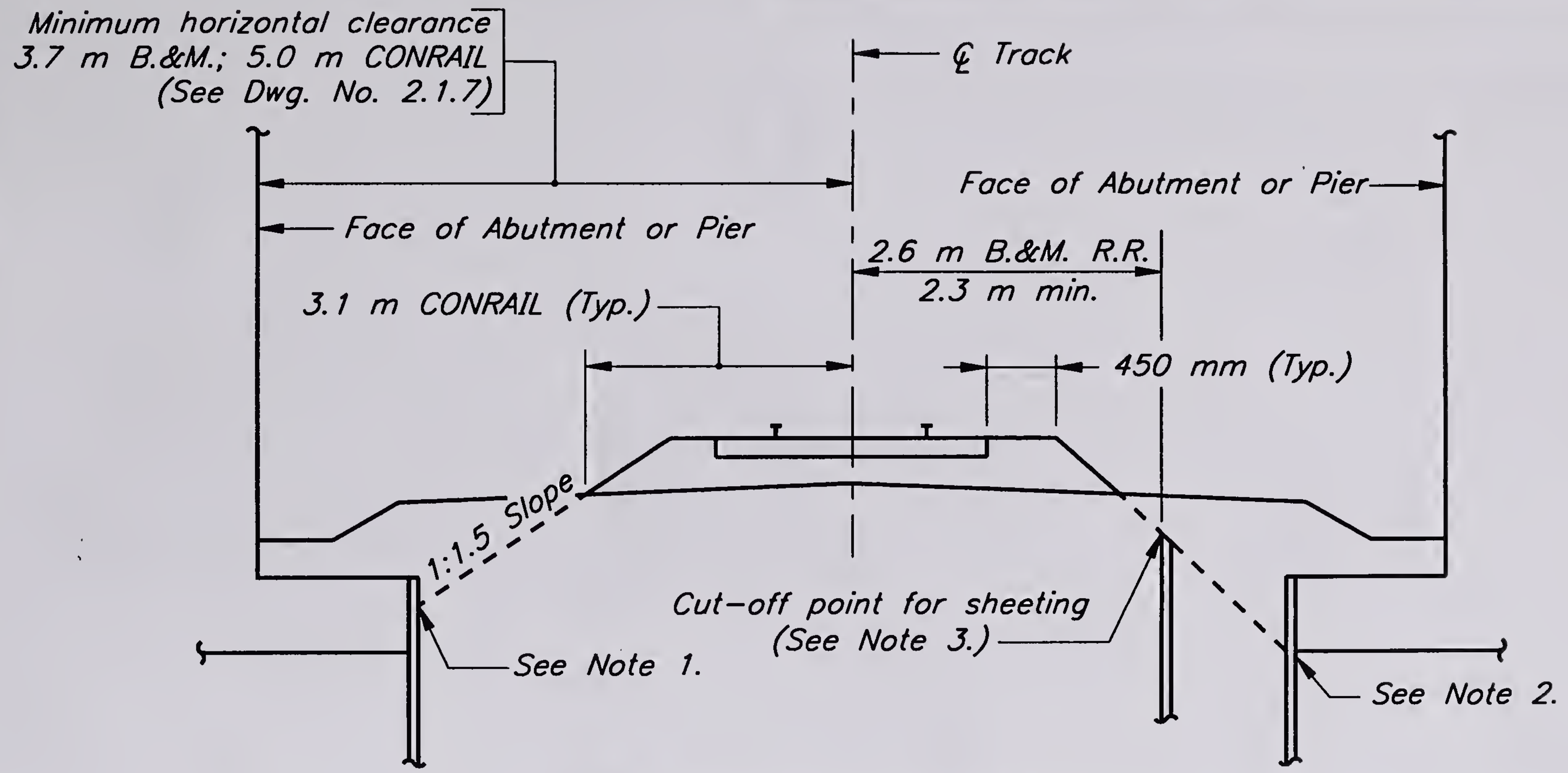
MASS HIGHWAY
BRIDGE MANUAL

RAILROAD
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.7

Plot Scale = 1:80



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

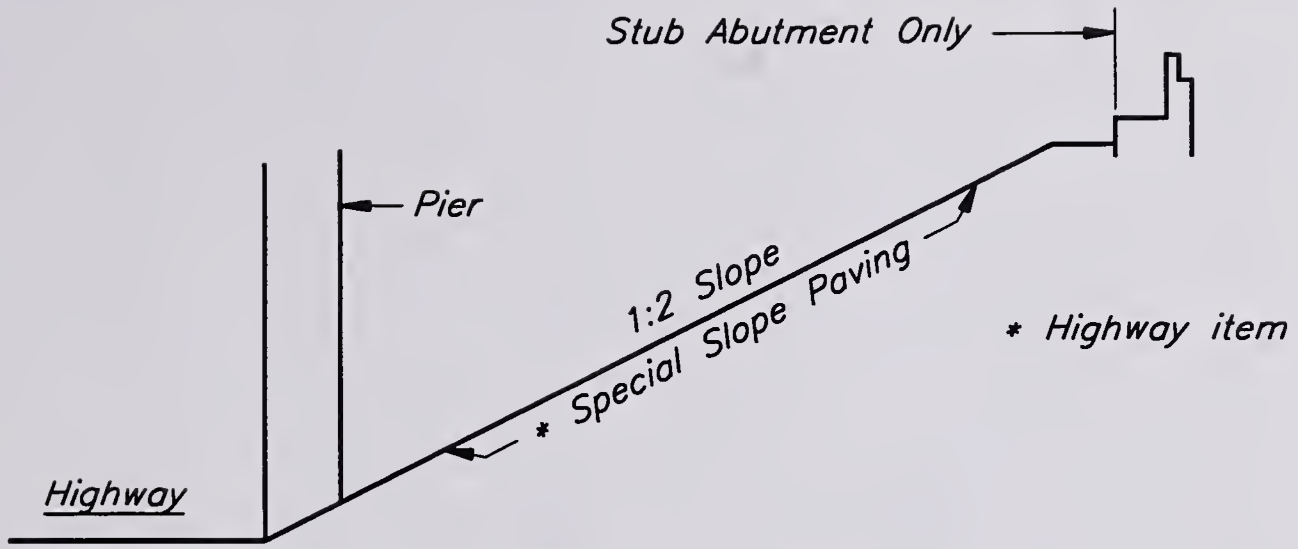
1. Provide sheeting whenever the 1:1.5 slope line would be disturbed in the placement of our structure.
2. If elevation of Bottom of Footing falls at or above the 1:1.5 slope line, steel sheeting is not required.
3. Sheet pile shall be cut off at top of footing or intersection with 1:1.5 influence line, whichever is higher.
4. Steel sheeting for the protection of railroad shall be designed in accordance with provisions of A.R.E.A specifications. Extent of sheeting shall be dimensioned on plan view of bridge.
5. For Conrail, and as a minimum for other railroads, Sheeting is to be designed for a lateral earth pressure from E-80 loading surcharge. The 355.9 kn surcharge shall be uniformly distributed over the tie length (2.59 m) and axle spacing (1.52 m). Horizontal pressure on the sheeting due to the E-80 surcharge shall be determined using Boussinesq analysis.

MASS HIGHWAY
BRIDGE
MANUAL

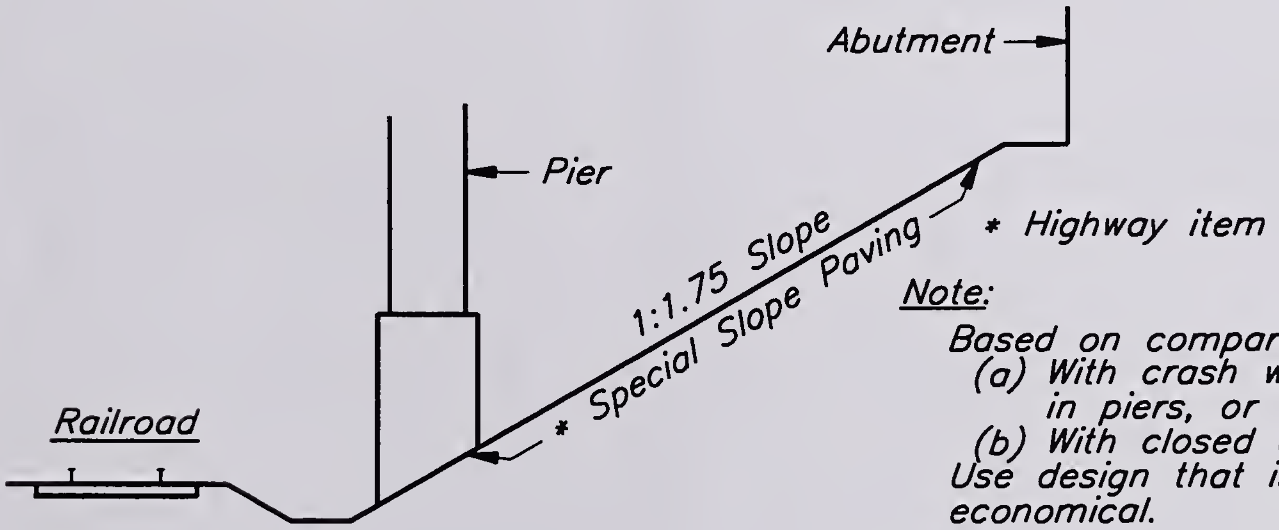
RAILROAD
(SHEET PILING REQUIREMENTS)
CLEARANCES UNDER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.8



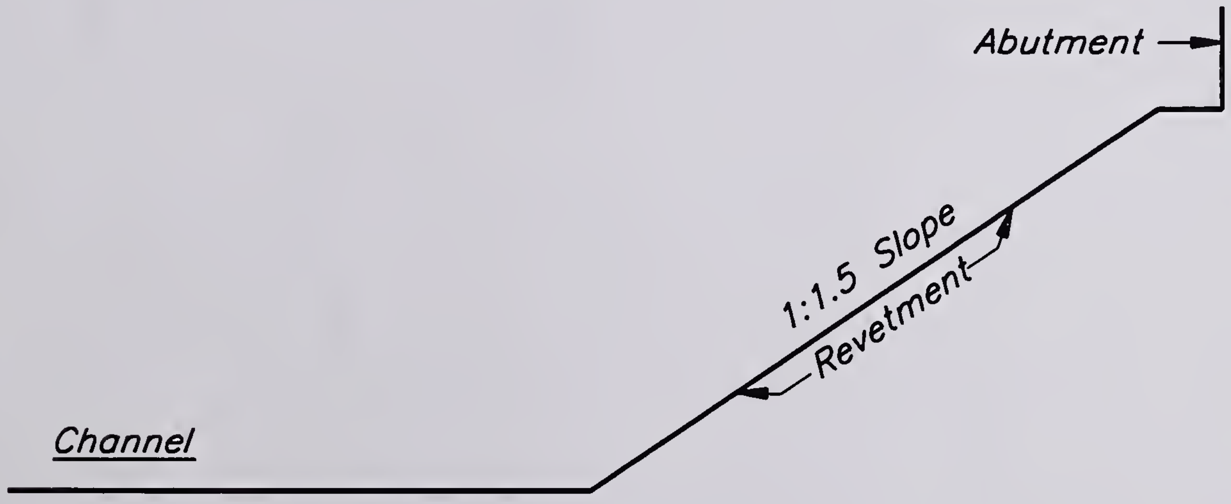
HIGHWAY OVER HIGHWAY
NOT TO SCALE



Note:

Based on comparison of cost:
(a) With crash walls incorporated in piers, or
(b) With closed abutments
Use design that is most economical.

HIGHWAY OVER RAILROAD
NOT TO SCALE



HIGHWAY OVER RIVER
NOT TO SCALE

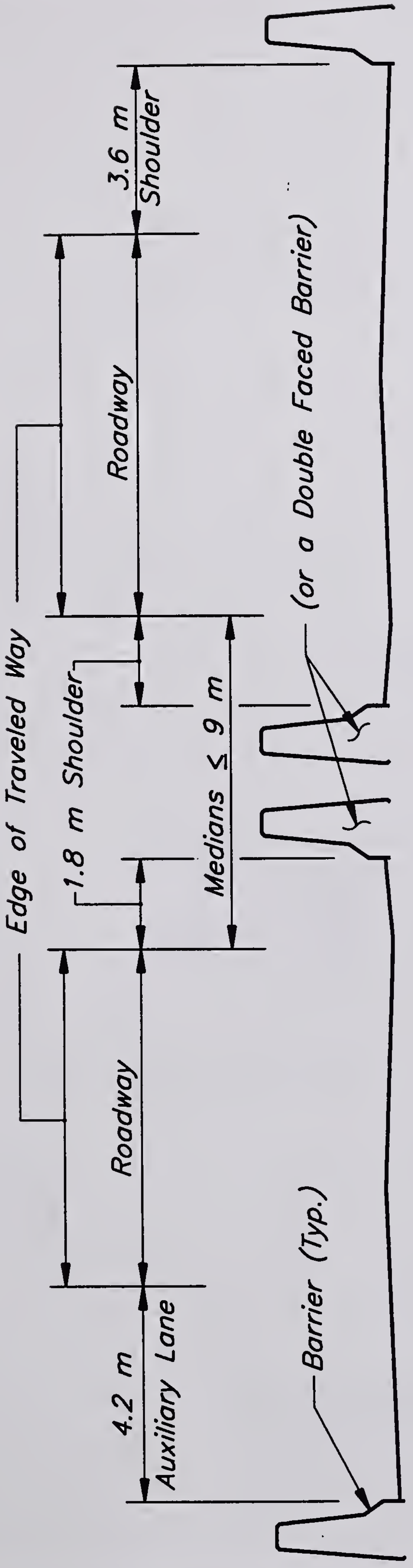
Plot Scale = 1:1

MASS HIGHWAY
BRIDGE
MANUAL

END SPAN SLOPES
CLEARANCES UNDER BRIDGE

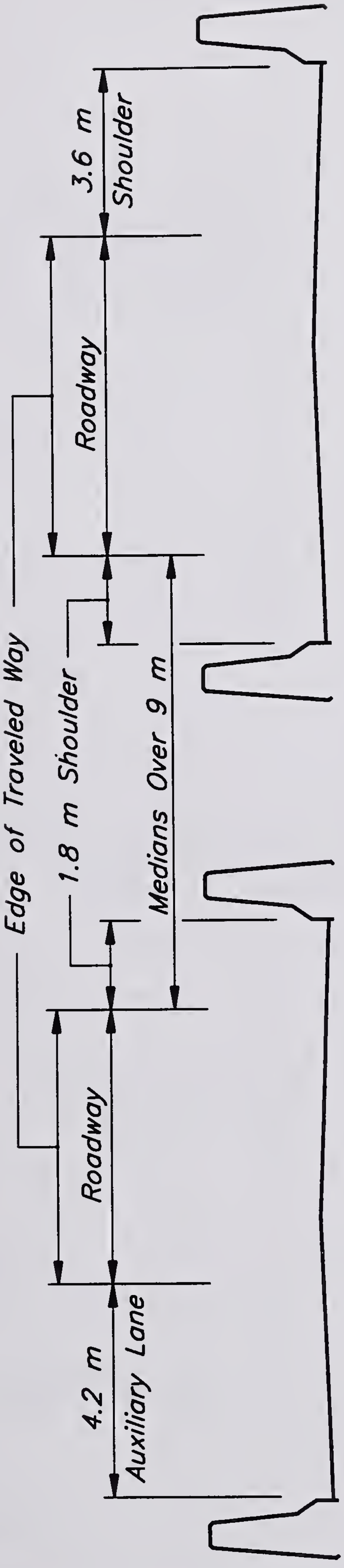
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.1.9



SINGLE STRUCTURE WITH CLOSED MEDIAN

NOT TO SCALE



DOUBLE STRUCTURES WITH OPEN MEDIAN

NOT TO SCALE

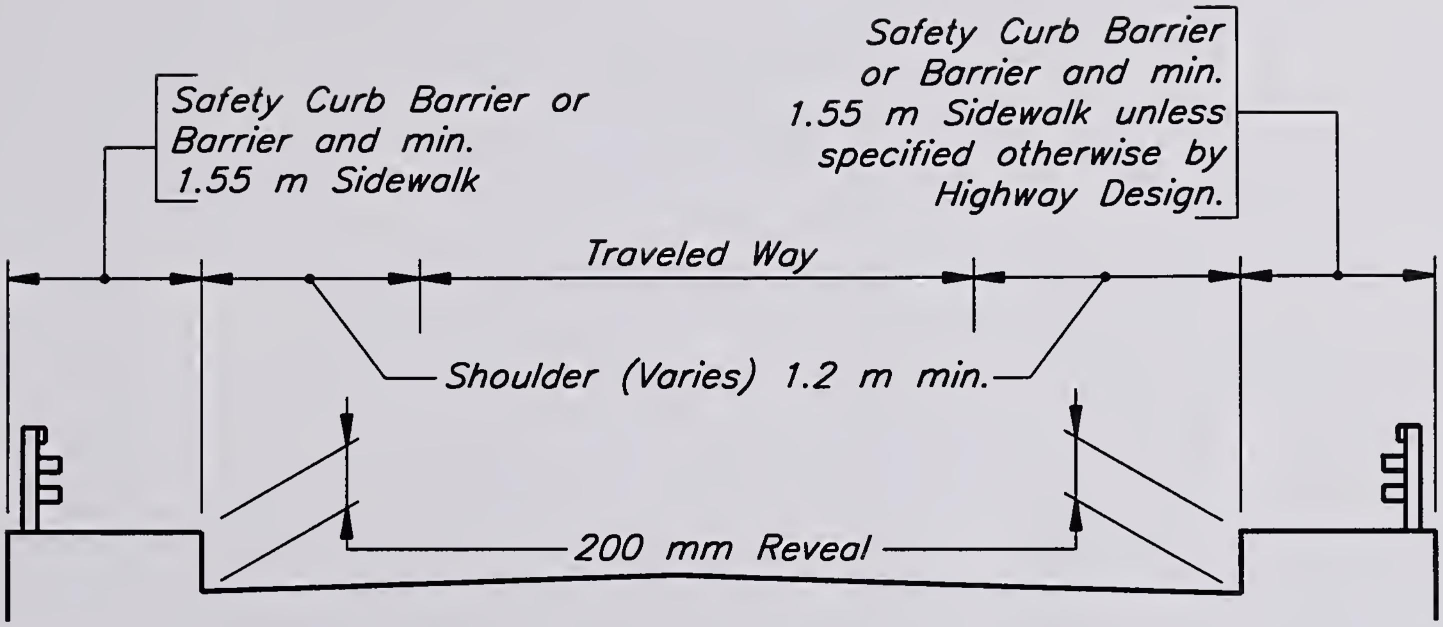
Plot Scale = 1:100

MASS HIGHWAY
BRIDGE
MANUAL

LIMITED ACCESS HIGHWAY
ROADWAY CROSS-SECTIONS
OVER BRIDGE

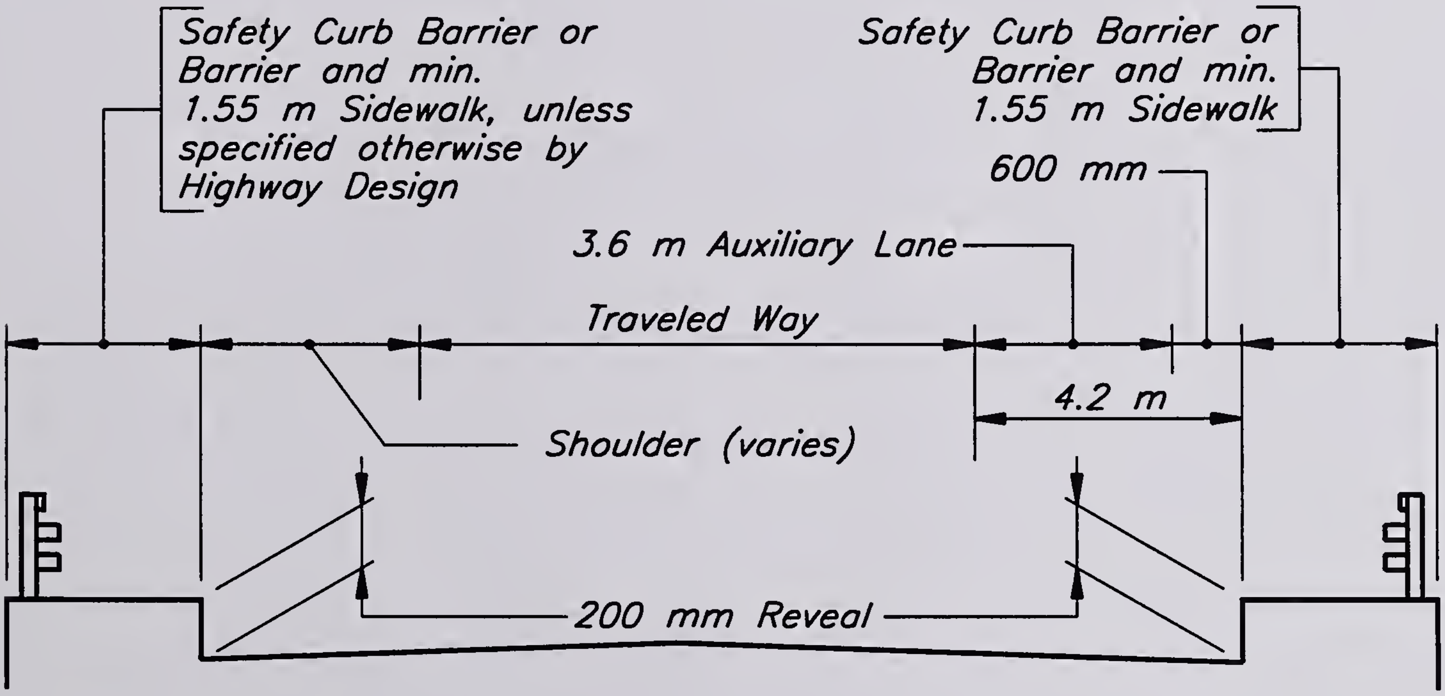
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.2.1



TYPICAL LOCAL ROAD

NOT TO SCALE



LOCAL ROAD WITH AUXILIARY LANE

NOT TO SCALE

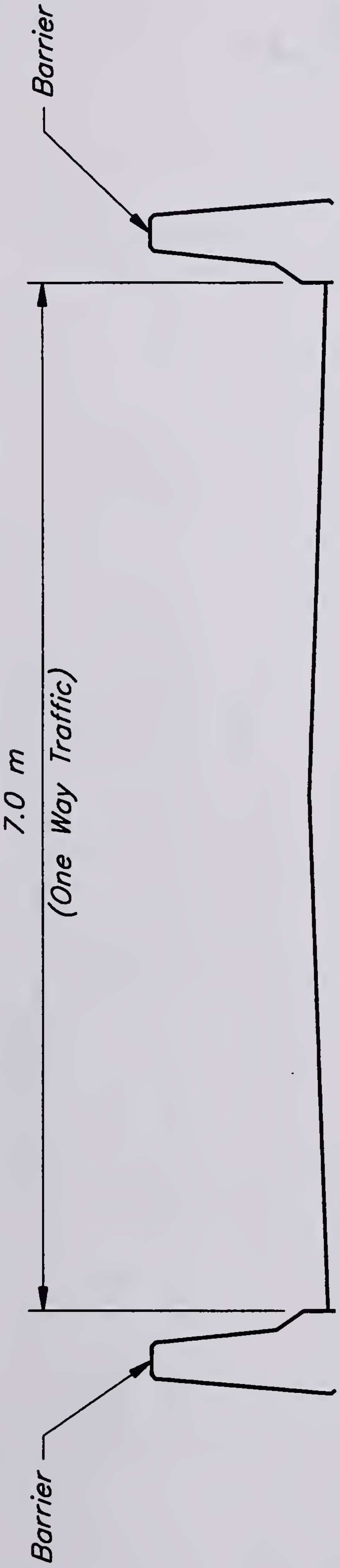
Plot Scale = 1:150

MASS HIGHWAY
BRIDGE
MANUAL

LOCAL ROAD
ROADWAY CROSS–SECTIONS
OVER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.2.2

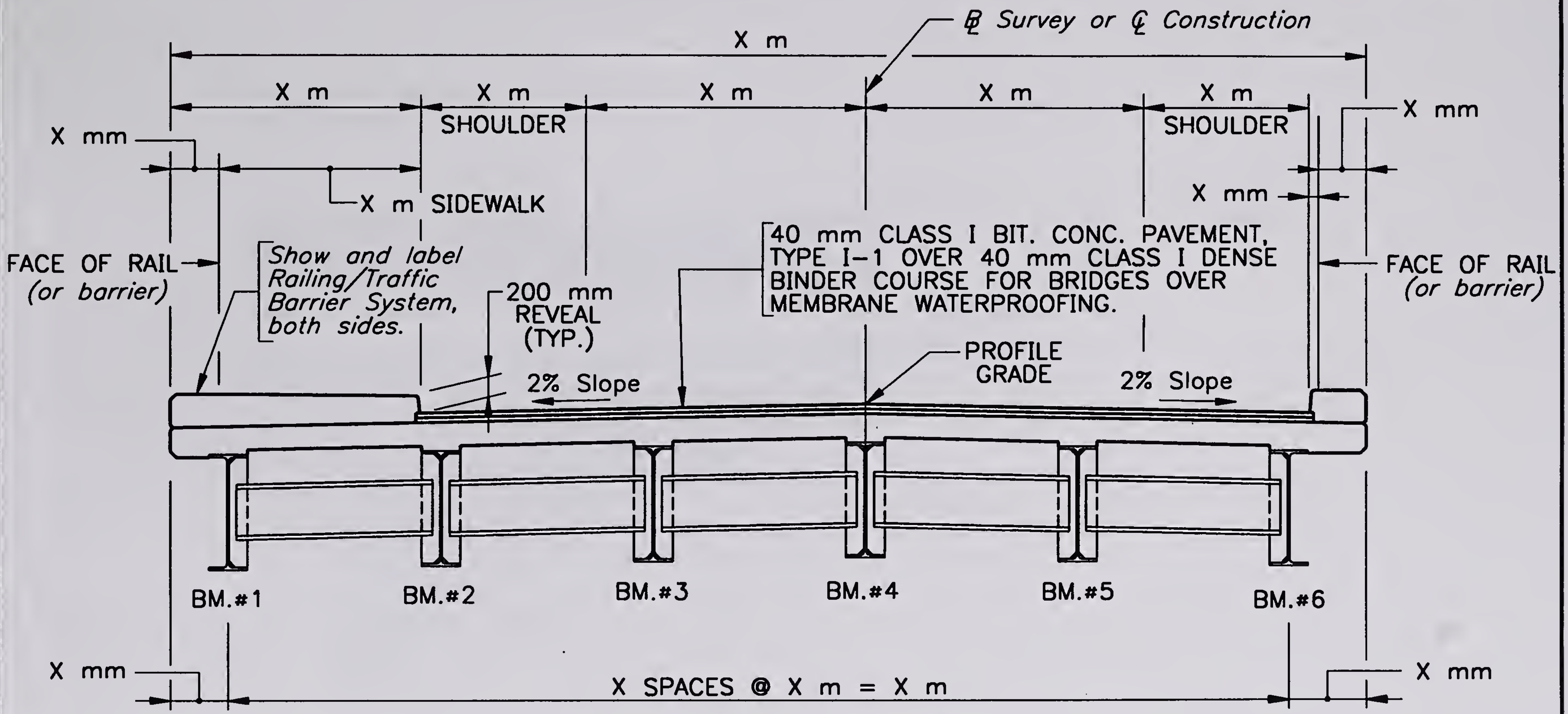


TYPICAL CROSS-SECTION
NOT TO SCALE

Plot Scale = 1:50

MASS HIGHWAY BRIDGE MANUAL	RAMP STRUCTURE ROADWAY CROSS-SECTIONS OVER BRIDGE	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **2.2.3**

Plot Scale = 1:50



Survey or Construction
X m
X m
X m
SHOULDER
X m
X m
X m
SHOULDER
X mm
X mm
X m SIDEWALK
X mm
FACE OF RAIL (or barrier)
FACE OF RAIL (or barrier)
Show and label Railing/Traffic Barrier System, both sides.
200 mm REVEAL (TYP.)
40 mm CLASS I BIT. CONC. PAVEMENT, TYPE I-1 OVER 40 mm CLASS I DENSE BINDER COURSE FOR BRIDGES OVER MEMBRANE WATERPROOFING.
PROFILE GRADE
2% Slope
2% Slope
BM.#1
BM.#2
BM.#3
BM.#4
BM.#5
BM.#6
X mm
X mm
X SPACES @ X m = X m

TRANSVERSE SECTION

NOT TO SCALE

NOTES:

1. *Transverse section shall be drawn to scale on the Construction Plans. All dimensions and items above shall be included and altered to suit the bridge project. Show and label all utilities. Steel stringer bridge shown as an example.*
2. *For bridges with a deck slab, Latex Modified Concrete (L.M.C.) Overlayment may be substituted for the Bituminous Concrete Pavement where the Profile Grade over the bridge is excessive.*

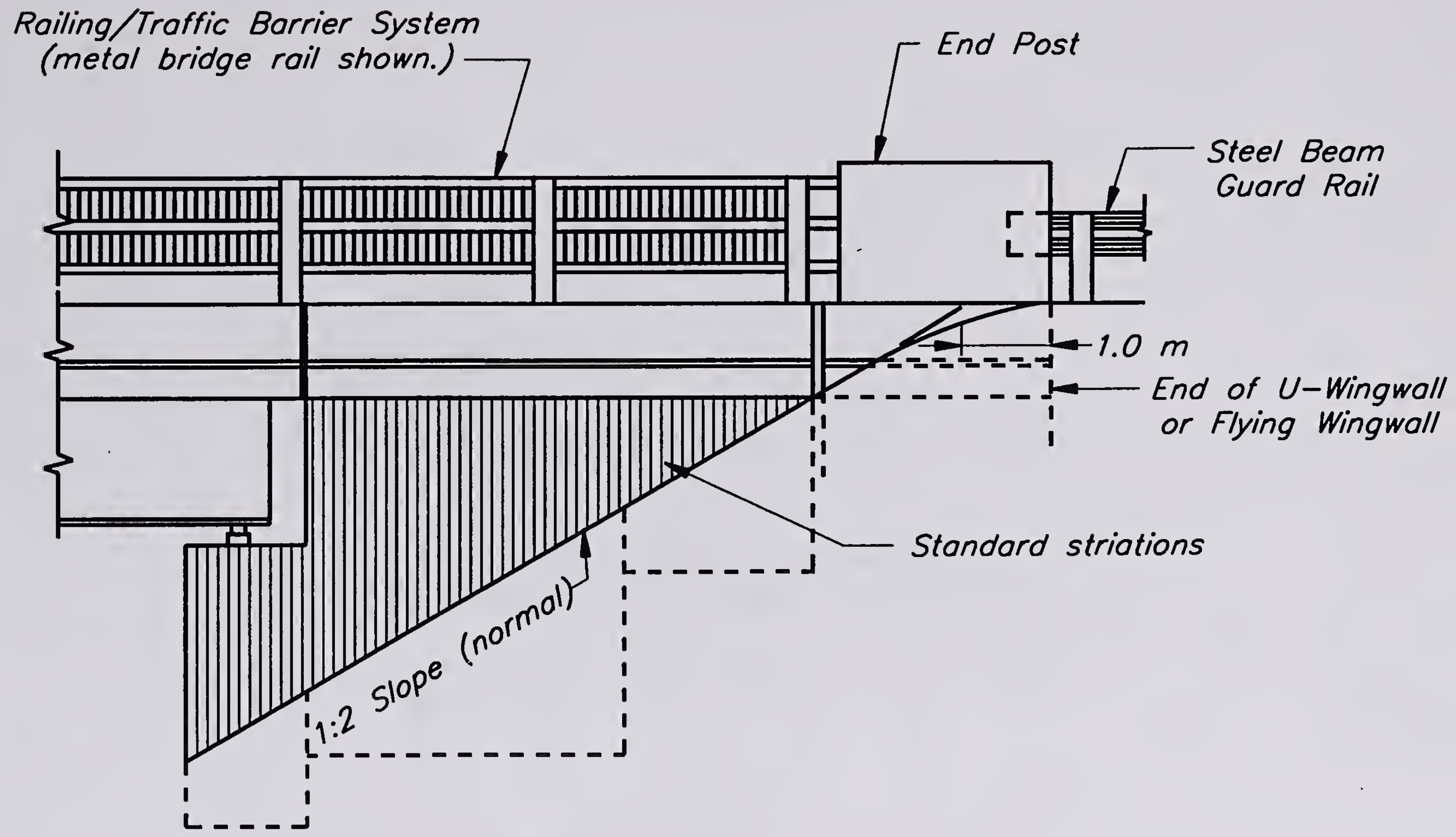
MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL TRANSVERSE SECTION
ROADWAY CROSS-SECTIONS
OVER BRIDGE

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.2.4

Plot Scale = 1:90



U–WINGWALL ELEVATION

NOT TO SCALE

NOTES:

1. U–Wingwall for butted precast beams is similar, except for curtain wall.
2. See Chapter 9 for Railing/Traffic Barrier systems and End Post details.
3. See Chapter 3, for standard striation details. Other treatment of face may be used subject to bridge engineer's approval.

MASS HIGHWAY
BRIDGE
MANUAL

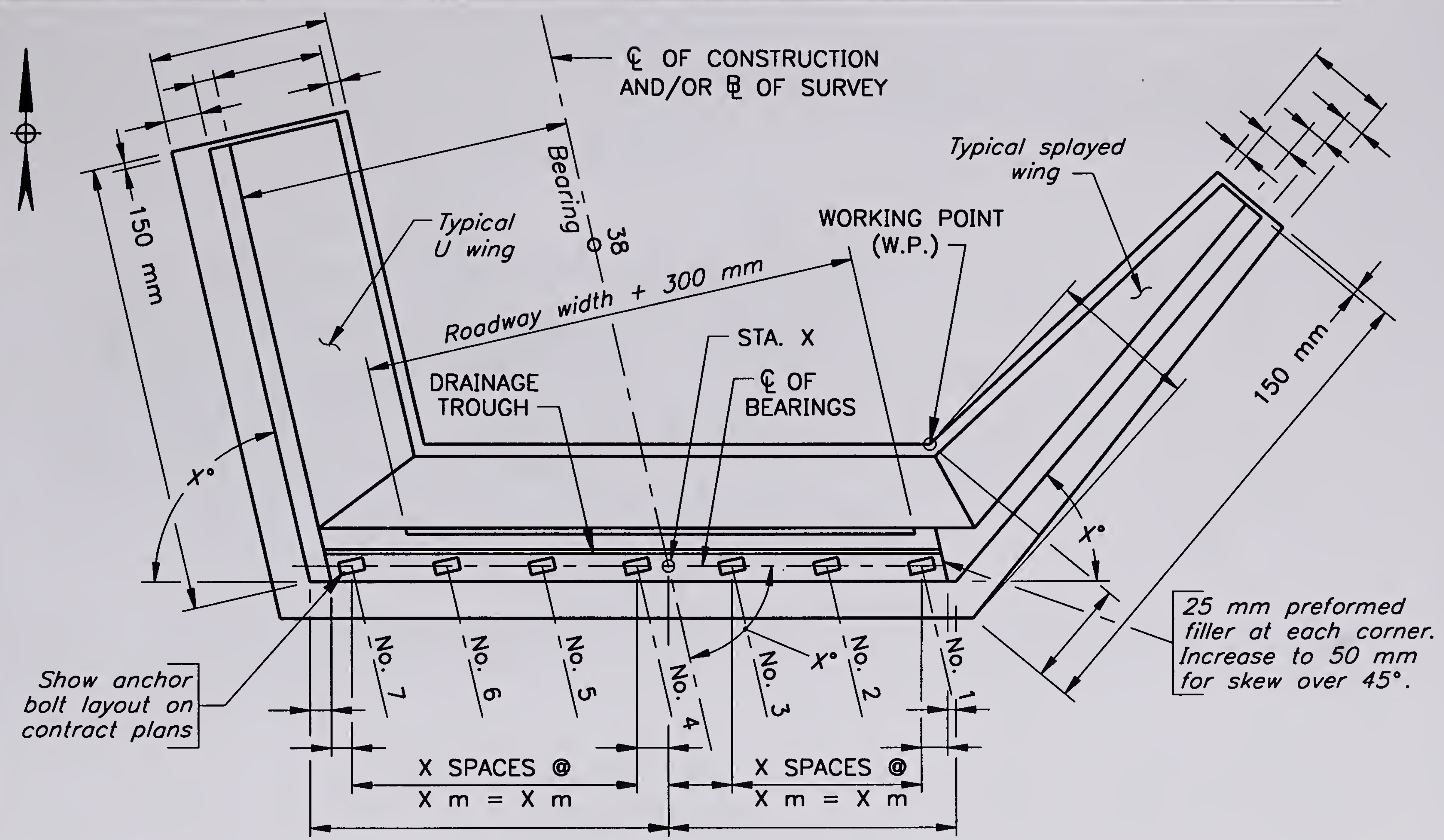
U–WINGWALL LENGTH

WINGWALL GEOMETRY

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
2.3.1

Plot Scale = 1:150



PLAN

SCALE (1:50 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *Expansion and Construction joints shall be located on the plan view on the construction drawings.*
3. *On the construction drawings, the plan view of each abutment shall be shown above and aligned with its elevation view.*
4. *For slab spans, frames and arches, the established reference point for stationing and dimensioning shall be the intersection of the center–line of construction with the face of abutment or the center–line of pier.*

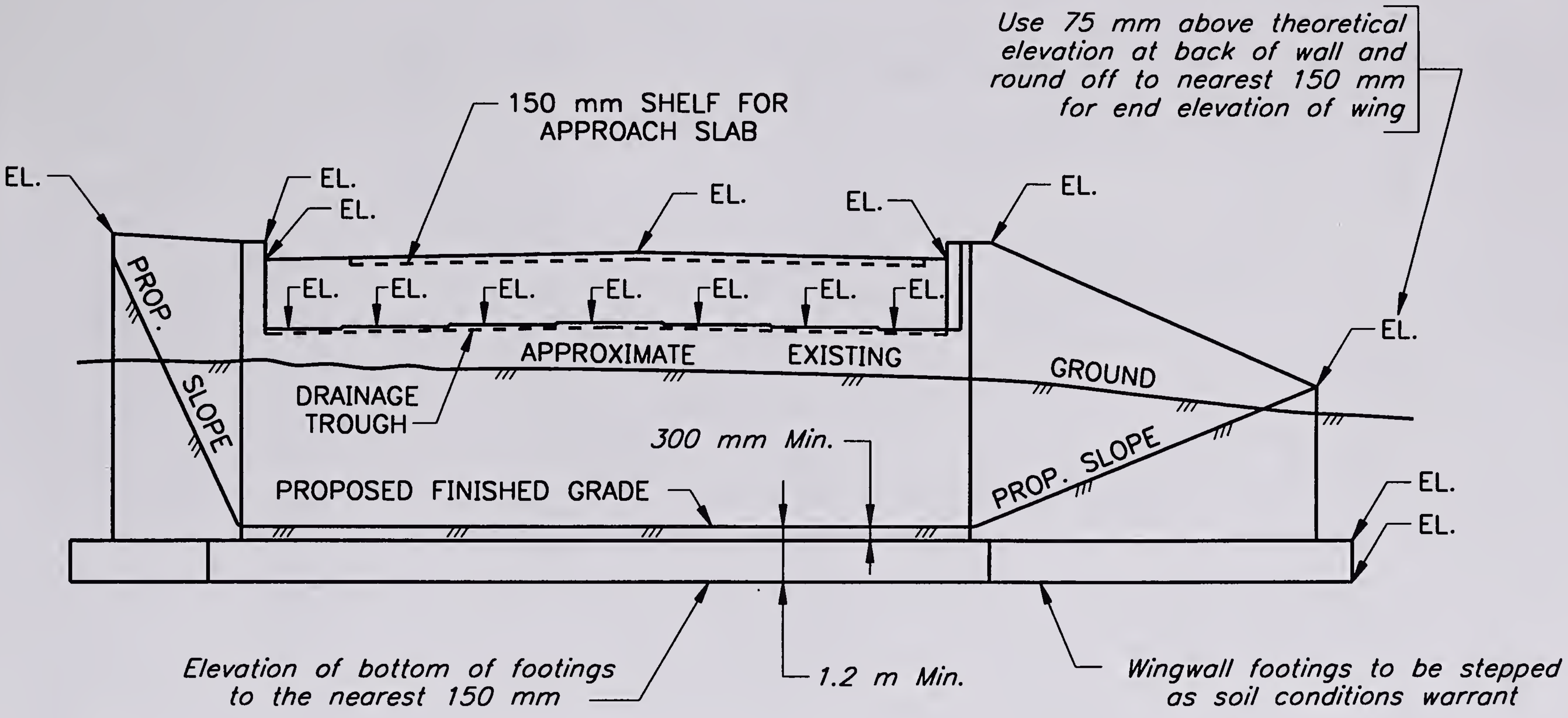
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL PLAN VIEW
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.1

Plot Scale = 1:150


Use 75 mm above theoretical elevation at back of wall and round off to nearest 150 mm for end elevation of wing
150 mm SHELF FOR APPROACH SLAB
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
EL.
PROP. SLOPE
APPROXIMATE EXISTING GROUND
DRAINAGE TROUGH
300 mm Min.
PROPOSED FINISHED GRADE
PROP. SLOPE
Elevation of bottom of footings to the nearest 150 mm
1.2 m Min.
Wingwall footings to be stepped as soil conditions warrant

ELEVATION

SCALE (1:50 min.)

NOTES:

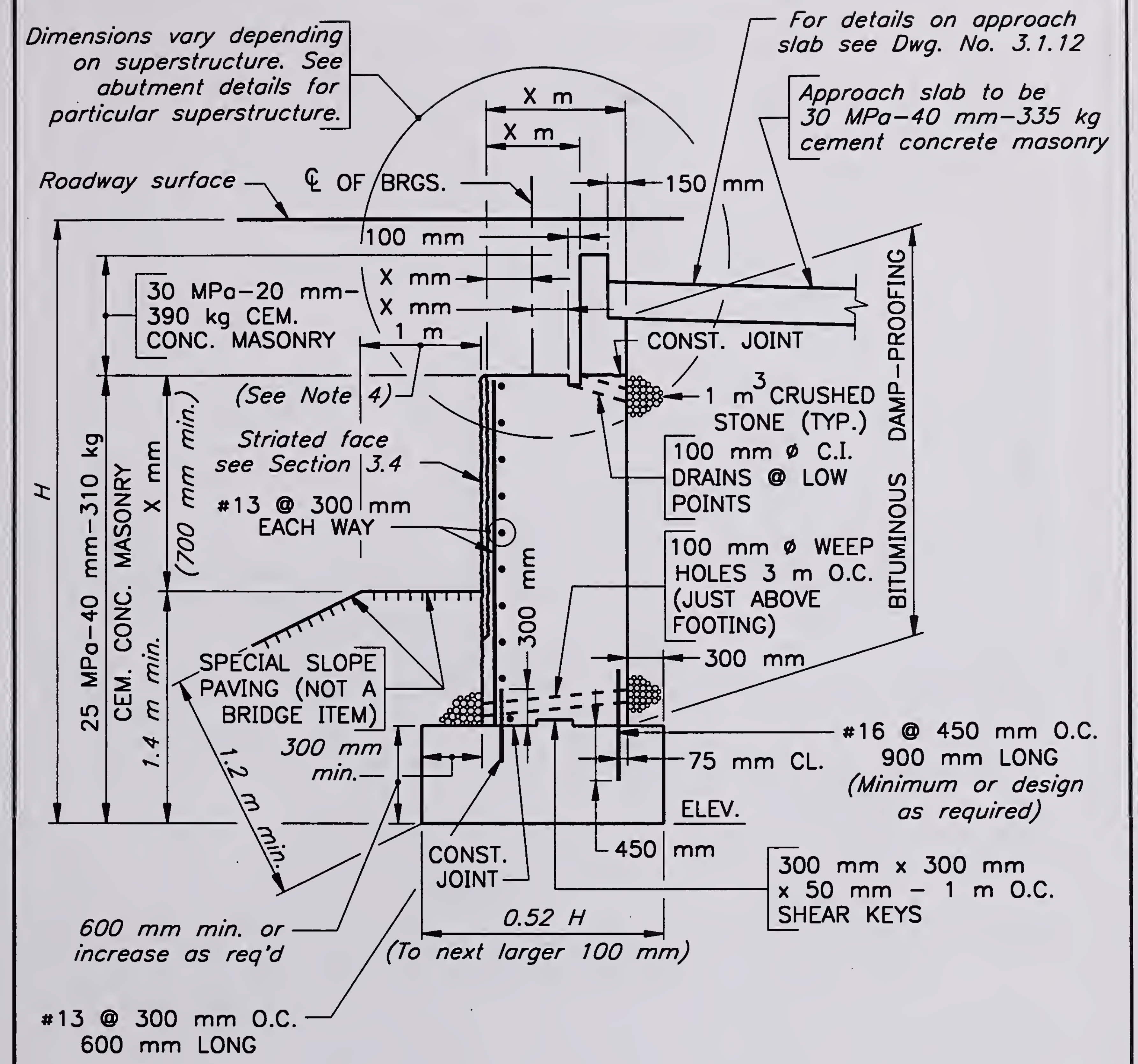
1. Above drawing is not to scale.
2. Show and label all expansion and construction joints.
3. Bridge seat elevations are to be figured to the bottom of masonry plates and so noted on the contract plans.

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL ELEVATION VIEW
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.2


Dimensions vary depending on superstructure. See abutment details for particular superstructure.
For details on approach slab see Dwg. No. 3.1.12
Approach slab to be 30 MPa–40 mm–335 kg cement concrete masonry
X m
X m
Roadway surface
℄ OF BRGS.
150 mm
100 mm
X mm
X mm
30 MPa–20 mm–390 kg CEM. CONC. MASONRY
1 m
CONST. JOINT
(See Note 4)
1 m^3 CRUSHED STONE (TYP.)
Striated face see Section 3.4
100 mm ø C.I. DRAINS @ LOW POINTS
#13 @ 300 mm EACH WAY
100 mm ø WEEP HOLES 3 m O.C. (JUST ABOVE FOOTING)
BITUMINOUS DAMP-PROOFING
H
25 MPa–40 mm–310 kg CEM. CONC. MASONRY
X mm (700 mm min.)
1.4 m min.
300 mm
SPECIAL SLOPE PAVING (NOT A BRIDGE ITEM)
300 mm
1.2 m min.
300 mm min.
#16 @ 450 mm O.C. 900 mm LONG (Minimum or design as required)
75 mm CL.
ELEV.
CONST. JOINT
450 mm
300 mm x 300 mm x 50 mm – 1 m O.C. SHEAR KEYS
600 mm min. or increase as req'd
0.52 H (To next larger 100 mm)
#13 @ 300 mm O.C. 600 mm LONG

TYPICAL ABUTMENT SECTION

NOT TO SCALE

NOTES:

1. *Above drawing is not to scale.*
2. *Show maximum toe pressure, or pile capacity if on piles.*
3. *If piles are required see Section 3.6.*
4. *All dimensions are for square sections.*
5. *Bridge seat dimensions given for particular superstructure may be increased to accomodate bearing devices if bridge is on excessive skew.*

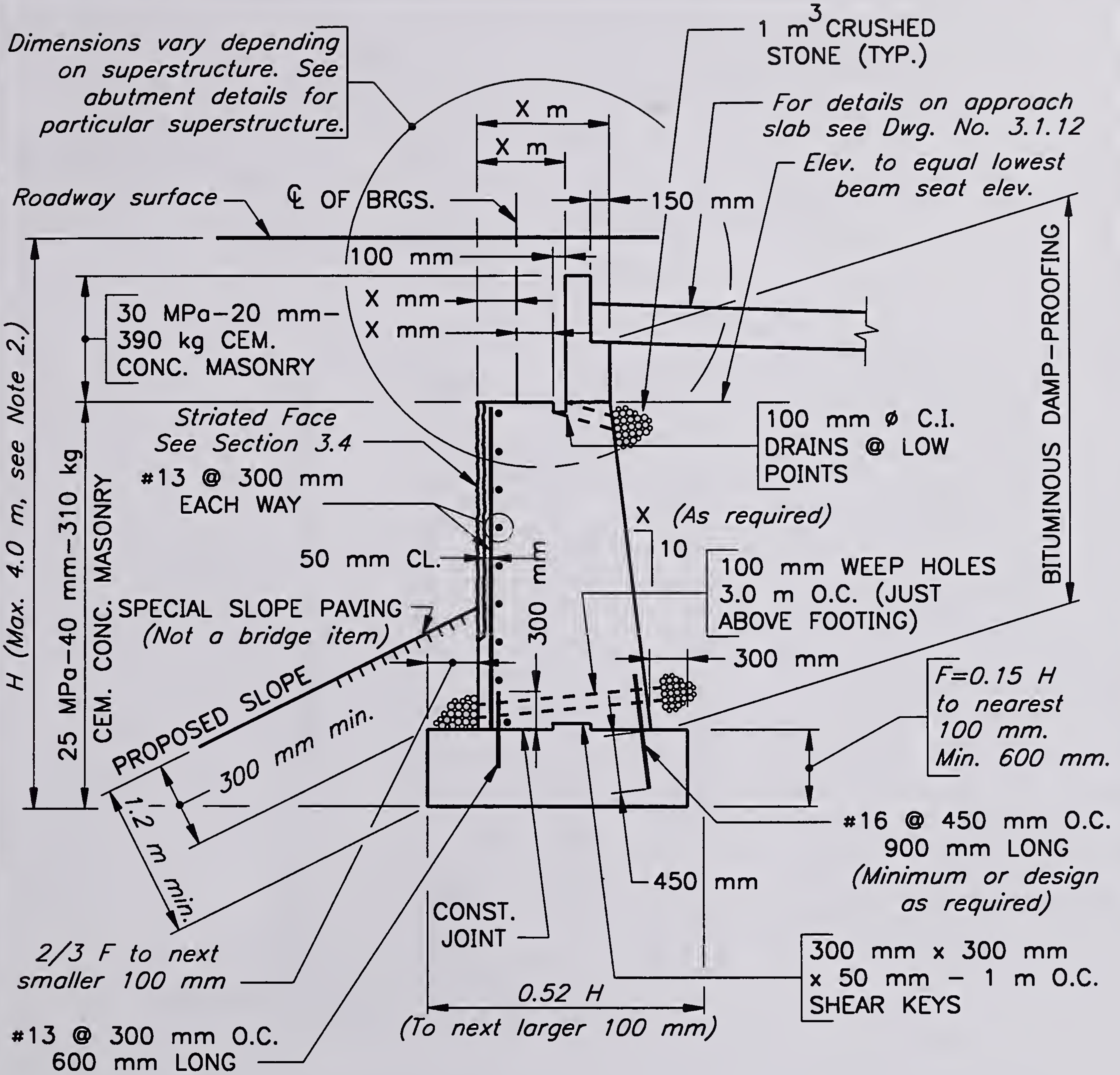
Plot Scale = 1:50

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL STUB ABUTMENT
SECTION
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.3


Dimensions vary depending on superstructure. See abutment details for particular superstructure.
1 m^3 CRUSHED STONE (TYP.)
X m
X m
For details on approach slab see Dwg. No. 3.1.12
Elev. to equal lowest beam seat elev.
Roadway surface
℄ OF BRGS.
150 mm
100 mm
X mm
X mm
30 MPa–20 mm–390 kg CEM. CONC. MASONRY
BITUMINOUS DAMP–PROOFING
H (Max. 4.0 m, see Note 2.)
25 MPa–40 mm–310 kg CEM. CONC. MASONRY
Striated Face See Section 3.4
100 mm ø C.I. DRAINS @ LOW POINTS
#13 @ 300 mm EACH WAY
X (As required)
10
50 mm CL.
300 mm
100 mm WEEP HOLES 3.0 m O.C. (JUST ABOVE FOOTING)
SPECIAL SLOPE PAVING (Not a bridge item)
PROPOSED SLOPE
300 mm
F=0.15 H to nearest 100 mm. Min. 600 mm.
300 mm min.
1.2 m min.
#16 @ 450 mm O.C. 900 mm LONG (Minimum or design as required)
450 mm
CONST. JOINT
2/3 F to next smaller 100 mm
300 mm x 300 mm x 50 mm – 1 m O.C. SHEAR KEYS
0.52 H (To next larger 100 mm)
#13 @ 300 mm O.C. 600 mm LONG

TYPICAL ABUTMENT SECTION

SCALE (1:50 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *Footing to be omitted when founded on ledge, for typical section see Drawing No. 3.6.4. H may be increased to 7 m.*
3. *Show maximum toe pressure or pile capacity if on piles.*
4. *Bridge seat dimensions given for a particular superstructure may be increased to accommodate bearing plates if bridge is on an excessive skew.*
5. *All dimensions are for a square section.*
6. *If piles are required, see Section 3.6.*

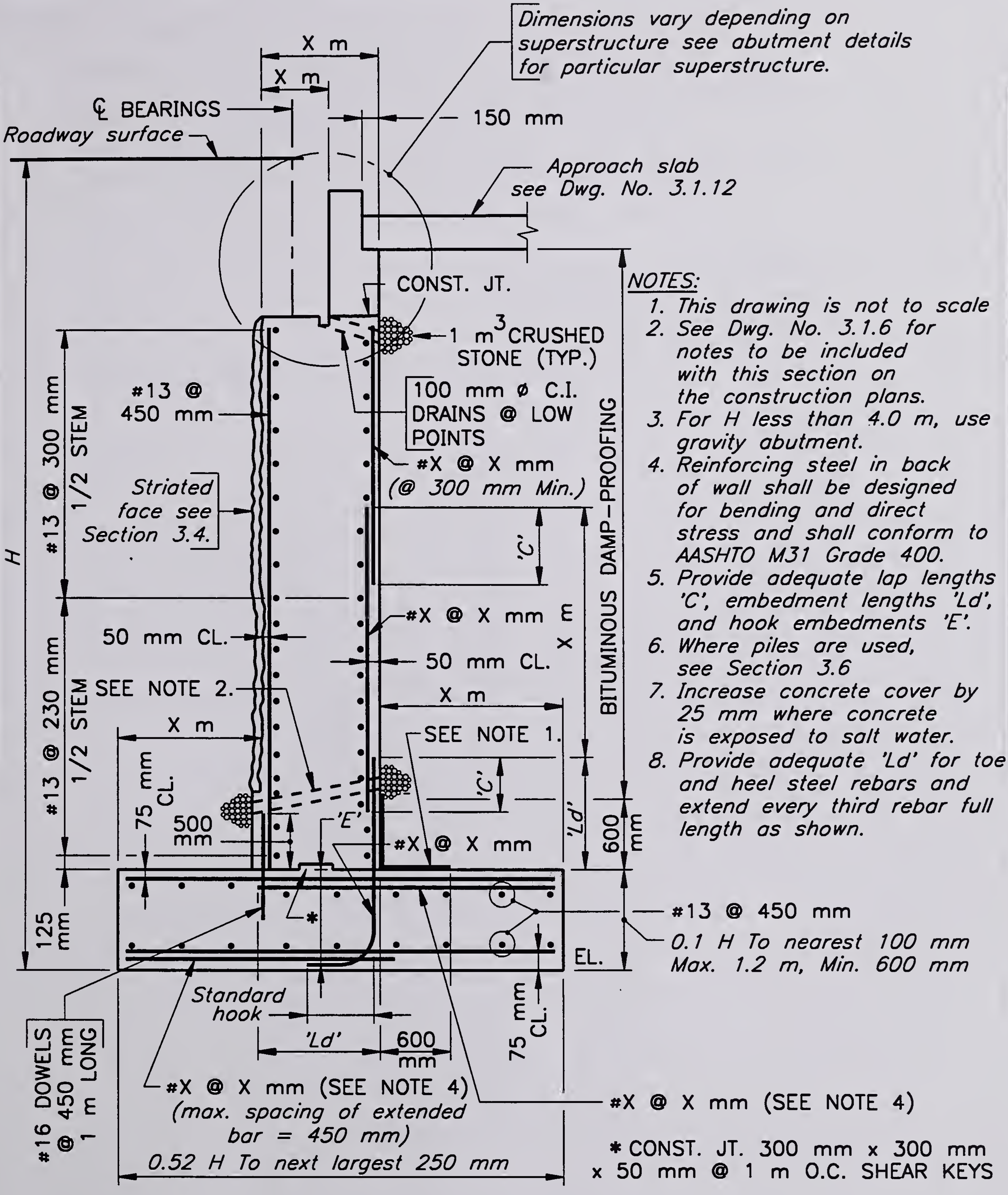
Plot Scale = 1:50

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL GRAVITY ABUTMENT
SECTION
ABUTMENT SECTIONS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.4


Dimensions vary depending on superstructure see abutment details for particular superstructure.
X m
X m
℄ BEARINGS
Roadway surface
150 mm
Approach slab see Dwg. No. 3.1.12
CONST. JT.
1 m³ CRUSHED STONE (TYP.)
100 mm ø C.I. DRAINS @ LOW POINTS
#13 @ 450 mm
#X @ X mm (@ 300 mm Min.)
Striated face see Section 3.4.
#13 @ 300 mm 1/2 STEM
H
'C'
BITUMINOUS DAMP-PROOFING
#X @ X mm
X m
50 mm CL.
50 mm CL.
#13 @ 230 mm 1/2 STEM
SEE NOTE 2.
X m
X m
SEE NOTE 1.
75 mm CL.
'C'
'Ld'
600 mm
500 mm
'E'
#X @ X mm
125 mm
#13 @ 450 mm
0.1 H To nearest 100 mm Max. 1.2 m, Min. 600 mm
EL.
*
Standard hook
'Ld'
600 mm
75 mm CL.
#16 DOWELS @ 450 mm 1 m LONG
#X @ X mm (SEE NOTE 4) (max. spacing of extended bar = 450 mm)
#X @ X mm (SEE NOTE 4)
0.52 H To next largest 250 mm
* CONST. JT. 300 mm x 300 mm x 50 mm @ 1 m O.C. SHEAR KEYS

NOTES:

1. *This drawing is not to scale*
2. *See Dwg. No. 3.1.6 for notes to be included with this section on the construction plans.*
3. *For H less than 4.0 m, use gravity abutment.*
4. *Reinforcing steel in back of wall shall be designed for bending and direct stress and shall conform to AASHTO M31 Grade 400.*
5. *Provide adequate lap lengths 'C', embedment lengths 'Ld', and hook embedments 'E'.*
6. *Where piles are used, see Section 3.6*
7. *Increase concrete cover by 25 mm where concrete is exposed to salt water.*
8. *Provide adequate 'Ld' for toe and heel steel rebars and extend every third rebar full length as shown.*

TYPICAL ABUTMENT SECTION

SCALE (1:50 min.)

Plot Scale = 1:50

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL CANTILEVER ABUTMENT
SECTION
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

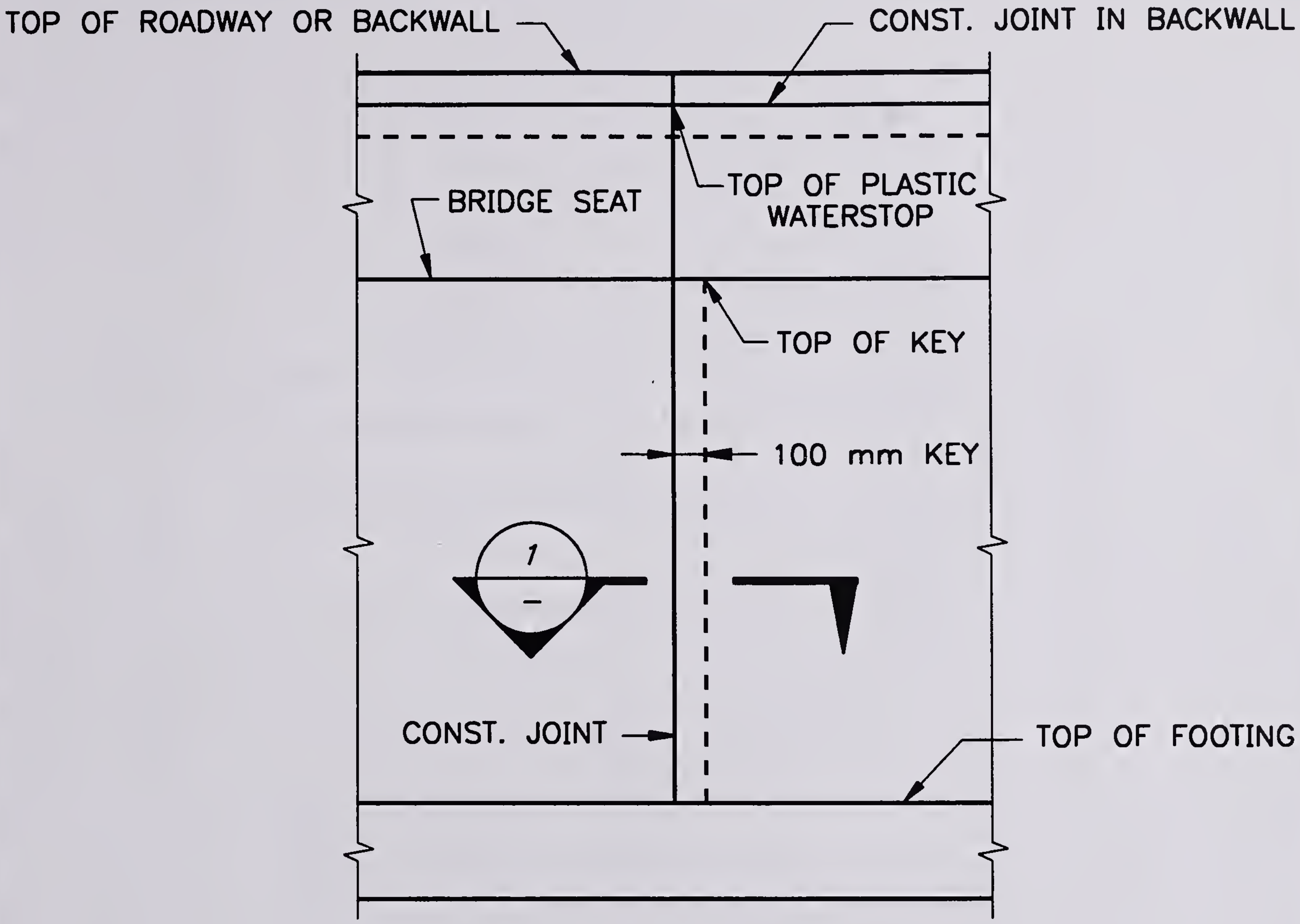
DRAWING NUMBER
3.1.5

NOTES: *(Include these notes with section shown on Dwg. No. 3.1.5)*

1. MEMBRANE WATERPROOFING AND 200 mm x 400 mm x 50 mm, 30 MPa–20 mm–390 kg CEMENT CONCRETE MASONRY BLOCKS LAID IN MORTAR OR OTHER WATERPROOFING PROTECTIVE COURSE, MIN. 50 mm THICK AS SPECIFIED IN M.H.D. STANDARD SPECIFICATIONS.
2. 100 mm WEEP HOLES 3 m O.C. (JUST ABOVE PROTECTIVE COURSE).
3. ALL CONCRETE SHALL BE 30 MPa–40 mm–335 kg CEMENT CONCRETE MASONRY EXCEPT THE BACKWALL, WHICH SHALL BE 30 MPa–20 mm–390 kg CEMENT CONCRETE MASONRY.
4. EXTEND EVERY THIRD BAR FULL LENGTH AS SHOWN.
5. MAXIMUM SOIL PRESSURE = XXXX kPa.

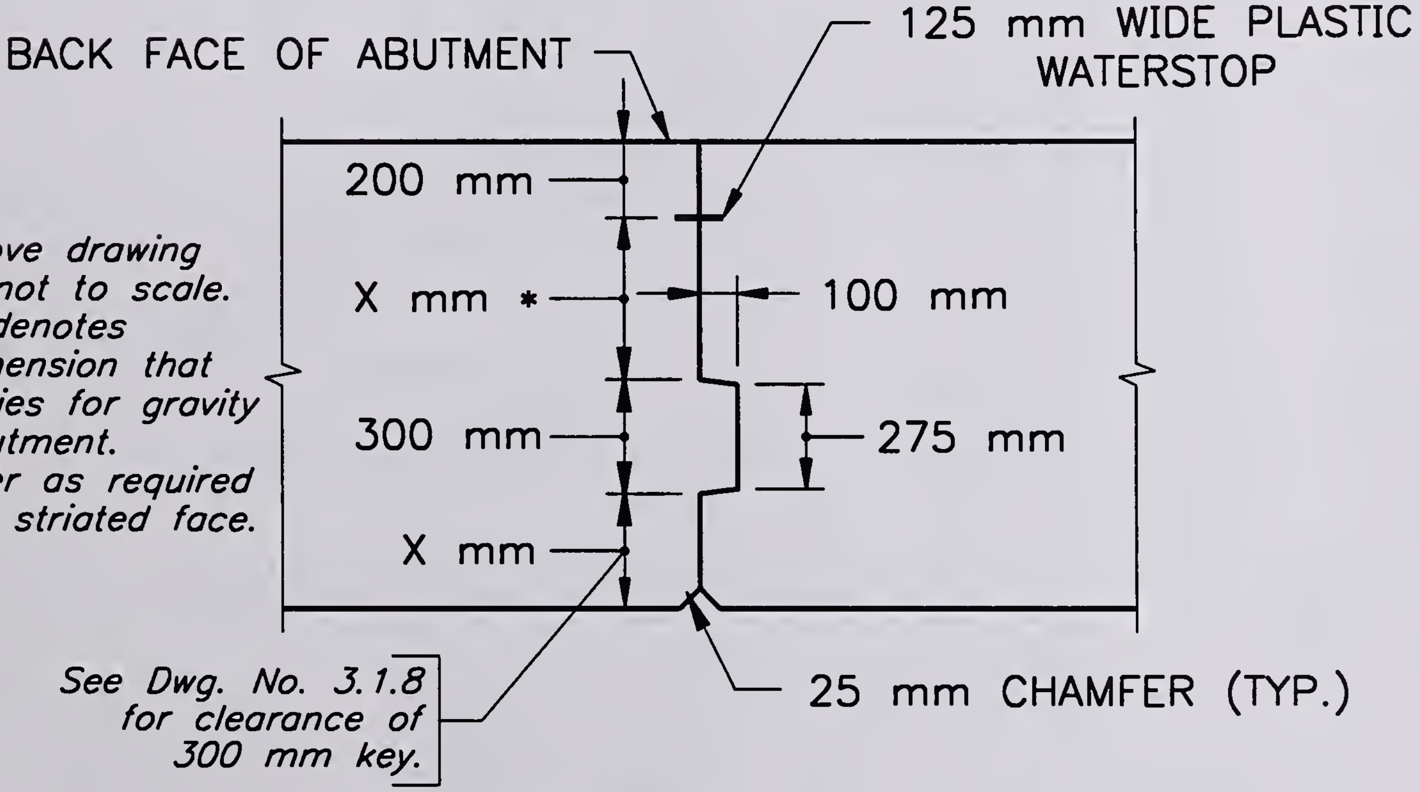
Plot Scale = 1:1

MASS HIGHWAY BRIDGE MANUAL	CONSTRUCTION NOTES FOR CANTILEVER ABUTMENT ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.1.6**



ELEVATION OF ABUTMENT

NOT TO SCALE


BACK FACE OF ABUTMENT
125 mm WIDE PLASTIC WATERSTOP
200 mm
X mm *
100 mm
300 mm
275 mm
X mm
25 mm CHAMFER (TYP.)
See Dwg. No. 3.1.8 for clearance of 300 mm key.

NOTES:

1. *Above drawing is not to scale.*
2. **–denotes dimension that varies for gravity abutment.*
3. *Alter as required for striated face.*

SECTION 1

SCALE (1:25 min.)

Plot Scale = 1:25

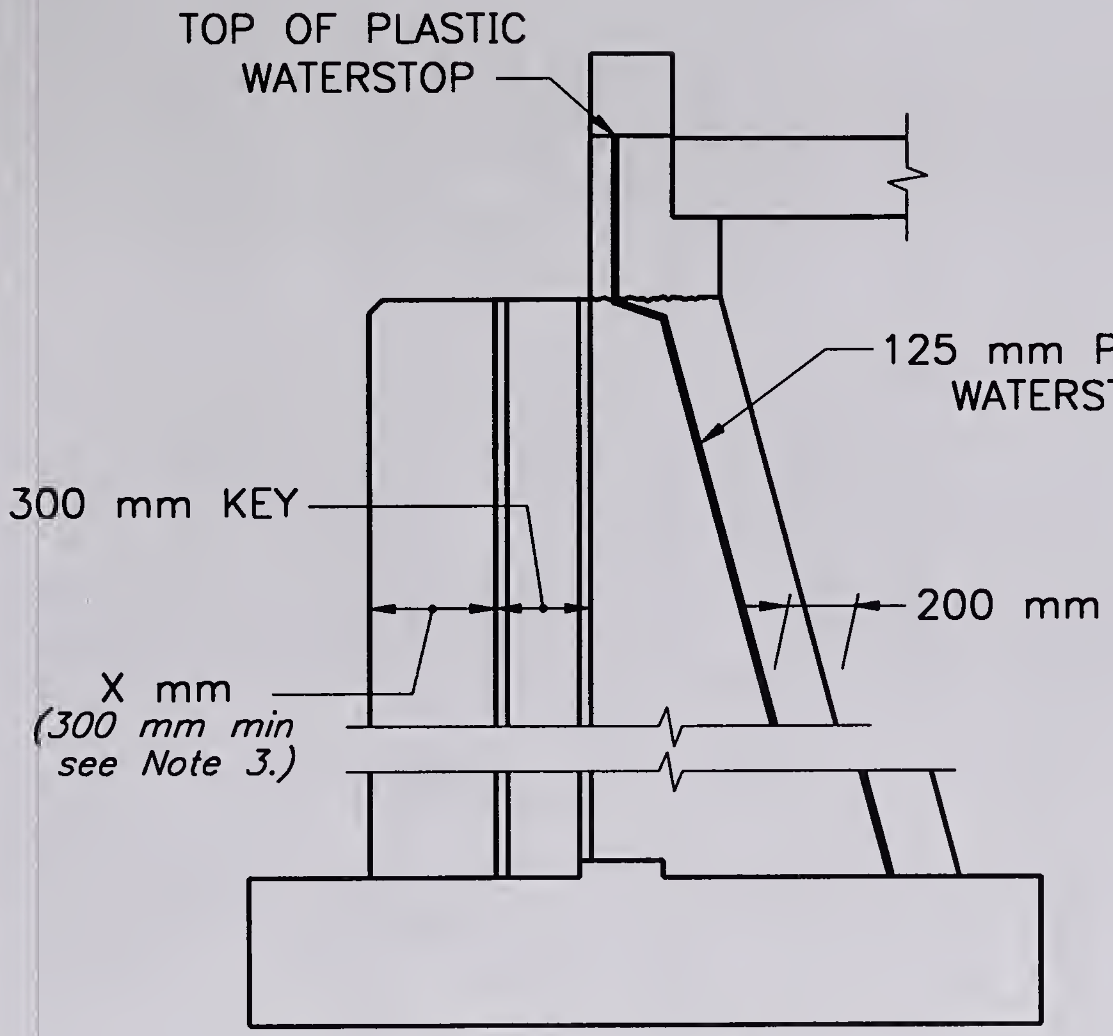
MASS HIGHWAY
BRIDGE
MANUAL

CONSTRUCTION JOINT DETAILS
ABUTMENT DETAILS

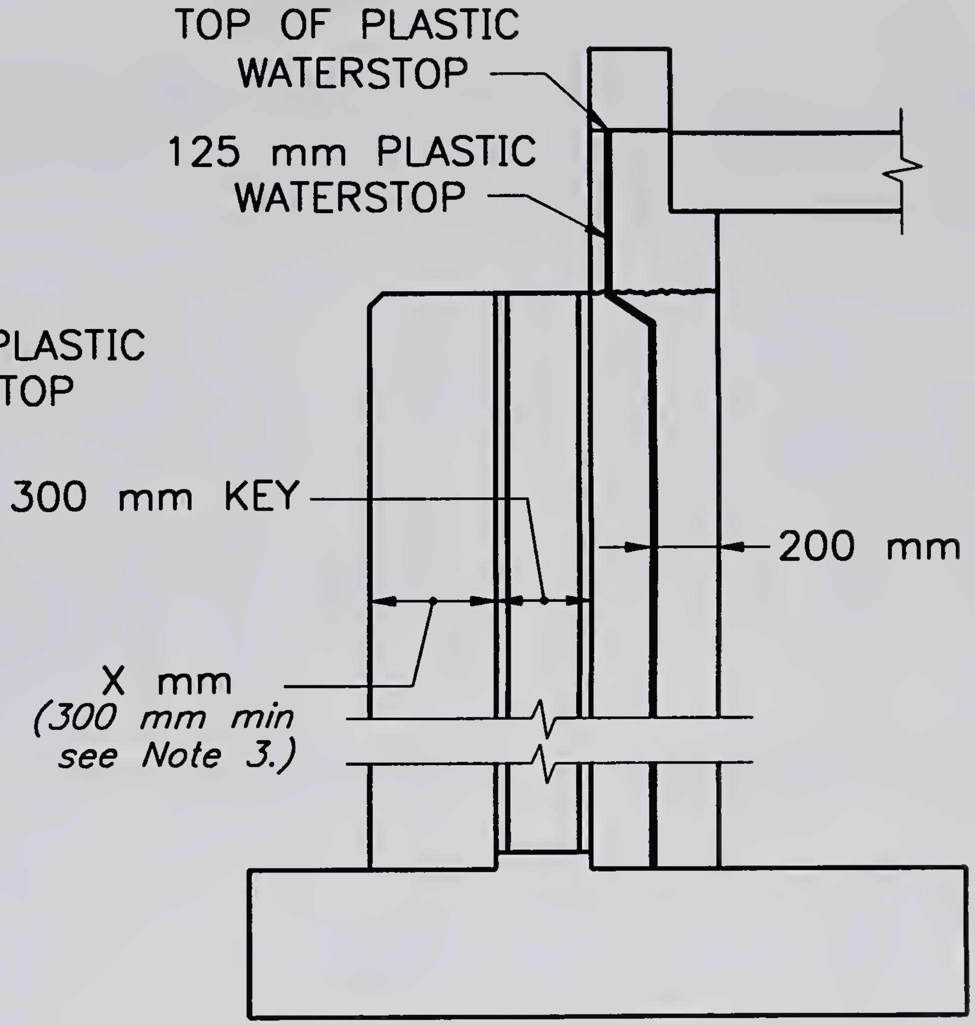
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.7

Plot Scale = 1:30



GRAVITY ABUTMENT



CANTILEVER ABUTMENT

NOTE: REINFORCEMENT SHALL BE CONTINUOUS THRU CONSTRUCTION JOINTS.

VERTICAL SECTION THRU CONSTRUCTION JOINT

NOT TO SCALE

NOTES:

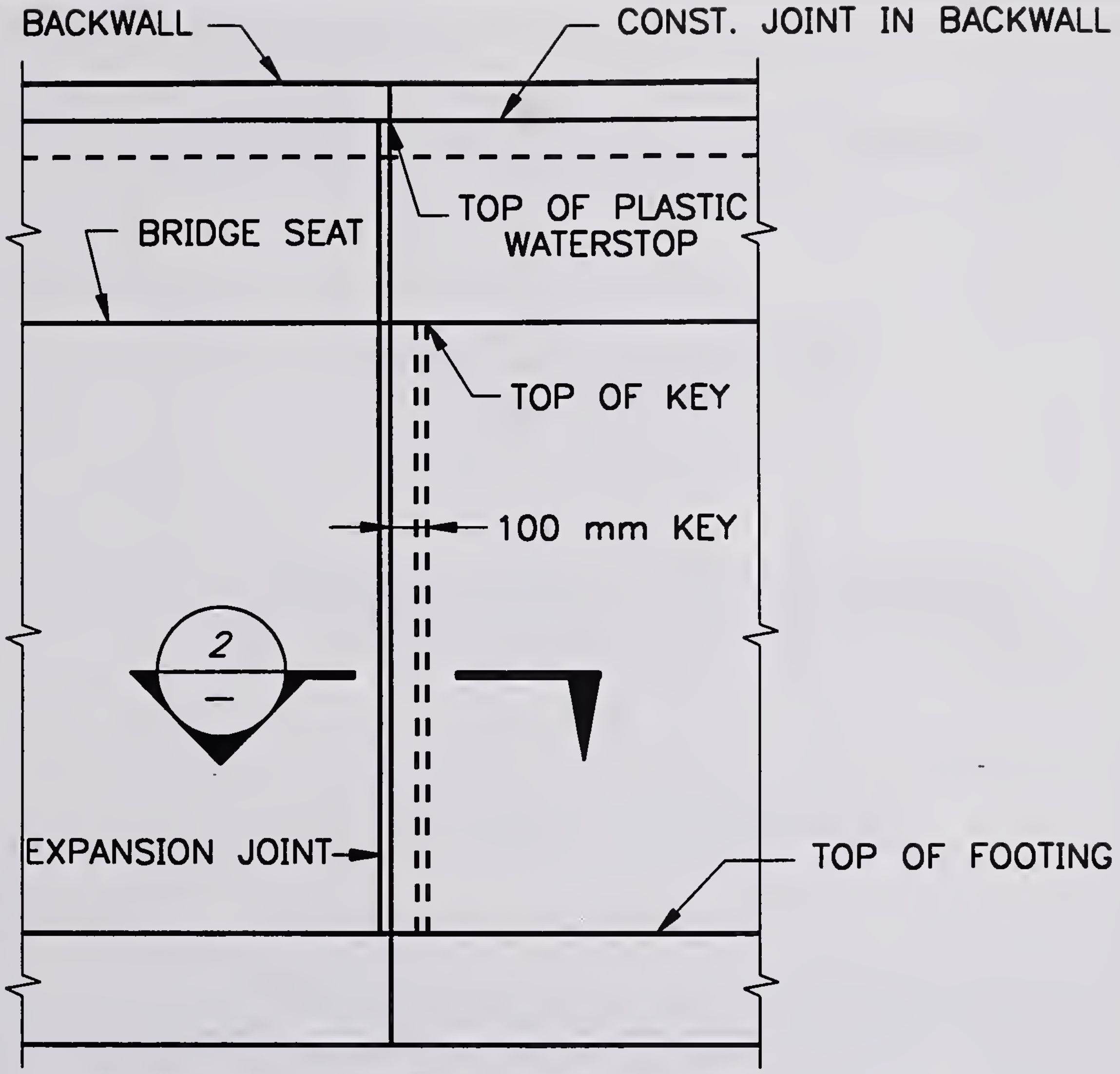
1. Construction joints shall be located at intervals of not more than 7 m.
2. Locate construction joints by dimensions on construction plans.
3. If 300 mm frontal clearance can not be achieved by placing end of 300 mm key at face of backwall, place key farther back to achieve 300 mm frontal clearance.

MASSHIGHWAY
BRIDGE
MANUAL

VERTICAL SECTION THRU
CONSTRUCTION JOINT
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

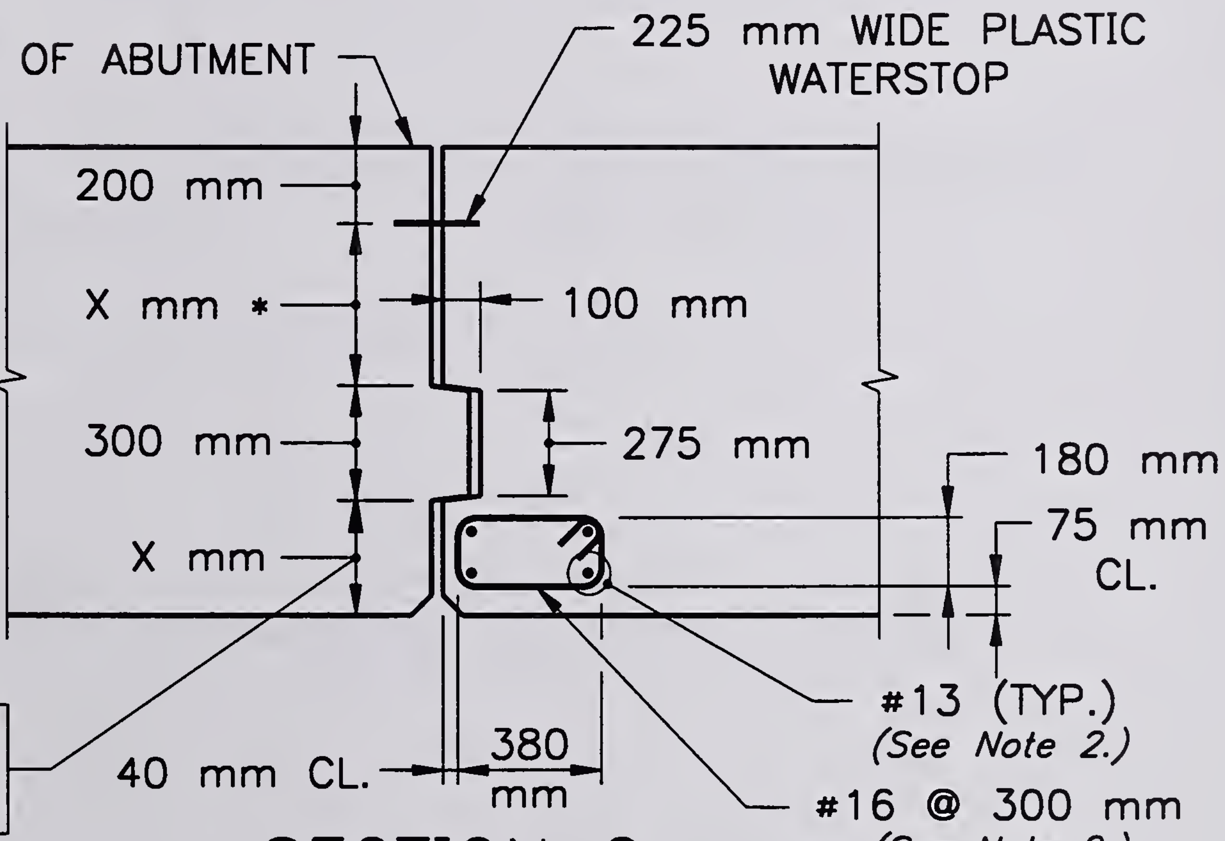
DRAWING NUMBER
3.1.8



ELEVATION OF ABUTMENT

NOT TO SCALE

NOTES:
1. Above drawing is not to scale.
2. Include extra reinforcement for walls 4 m or more in height.
3. ∗–denotes dimension that varies for gravity abutment.
4. Alter as required for striated face.



SECTION 2

SCALE (1:25 min.)

Plot Scale = 1:25

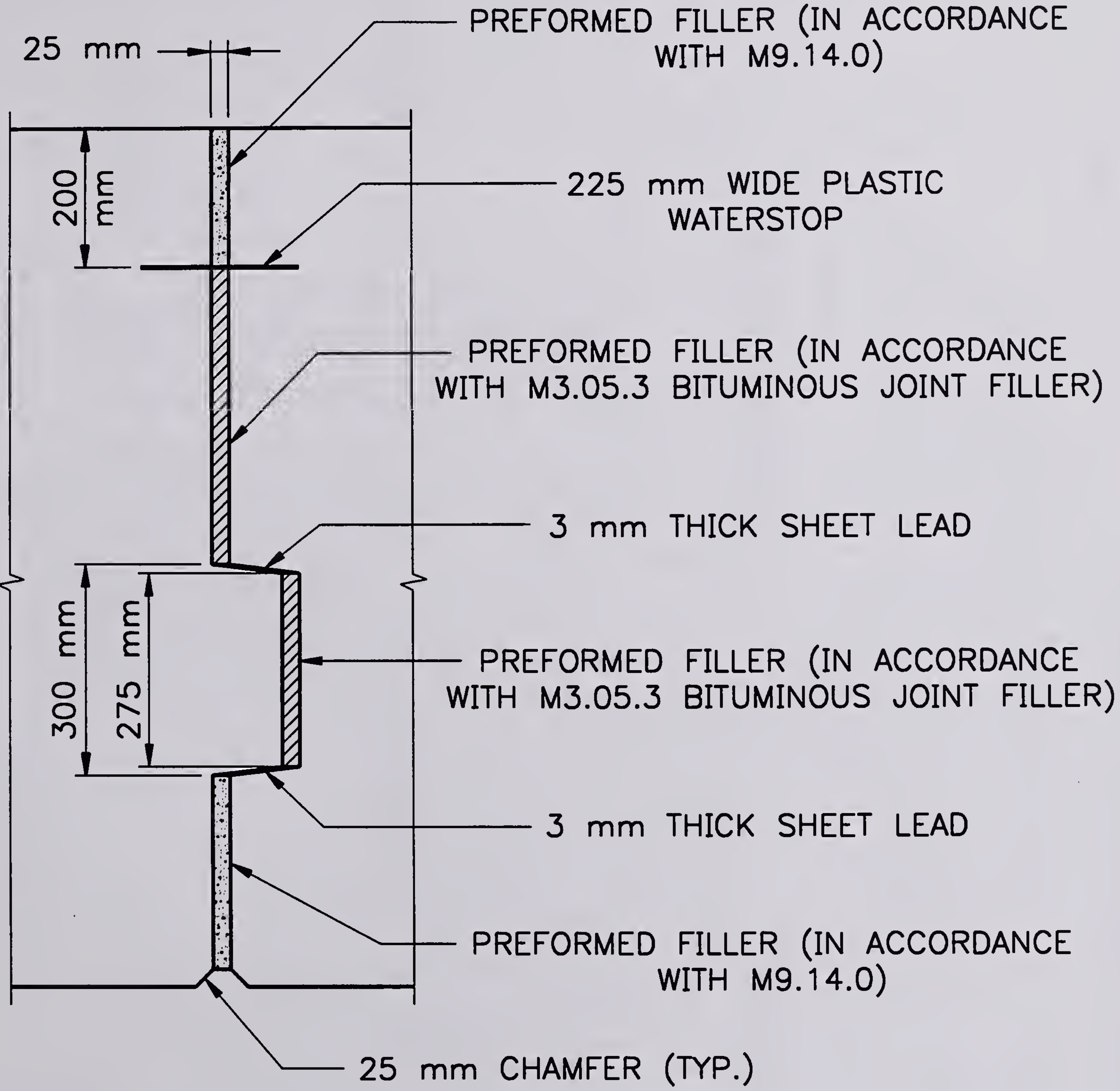
MASS HIGHWAY
BRIDGE MANUAL

EXPANSION JOINT DETAILS

ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.9


25 mm
PREFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
200 mm
225 mm WIDE PLASTIC WATERSTOP
PREFORMED FILLER (IN ACCORDANCE WITH M3.05.3 BITUMINOUS JOINT FILLER)
3 mm THICK SHEET LEAD
300 mm
275 mm
PREFORMED FILLER (IN ACCORDANCE WITH M3.05.3 BITUMINOUS JOINT FILLER)
3 mm THICK SHEET LEAD
PREFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
25 mm CHAMFER (TYP.)

LIMITS OF PREFORMED FILLER

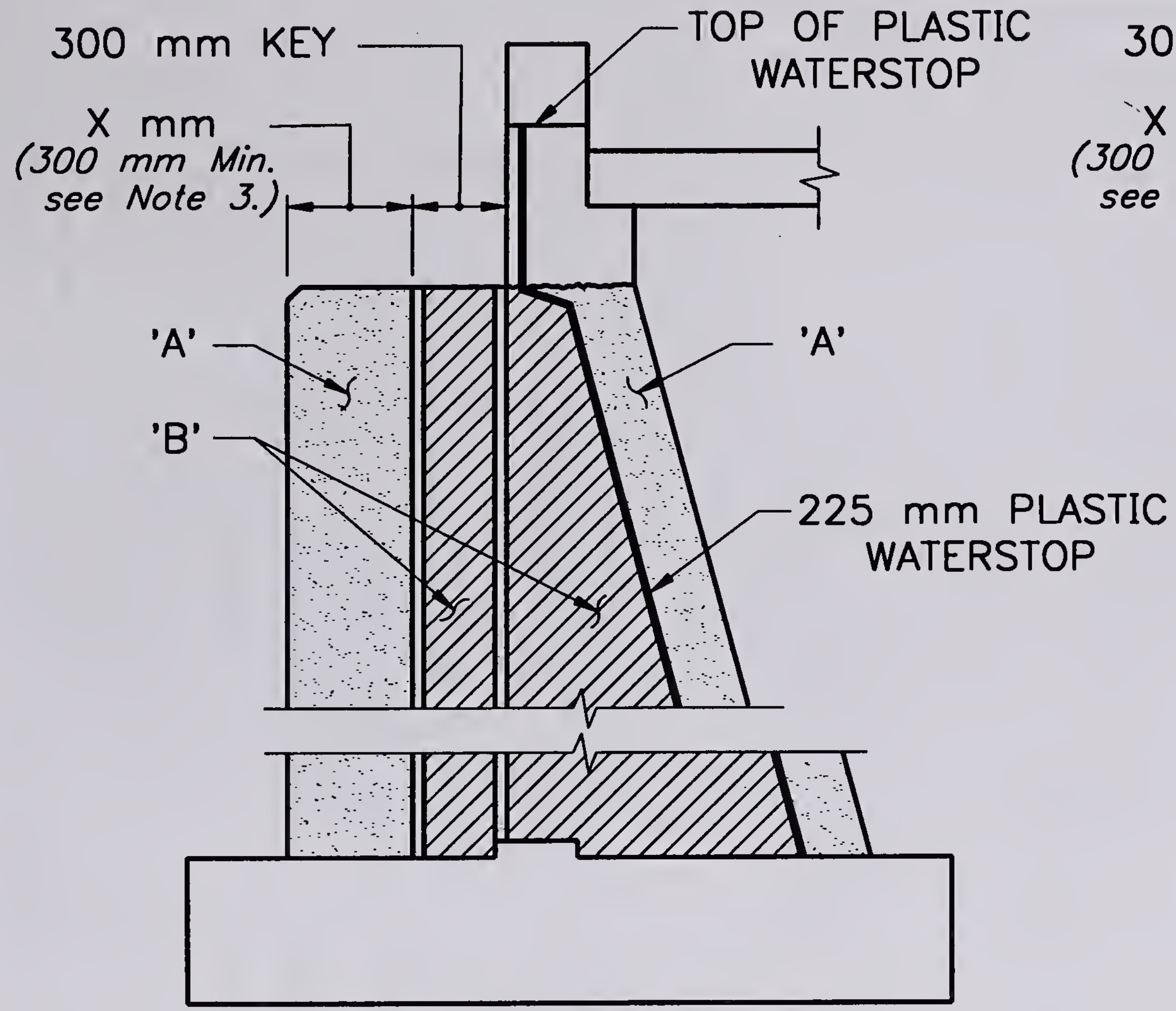
SCALE 1:10

NOTE: Alter as required for striated face.

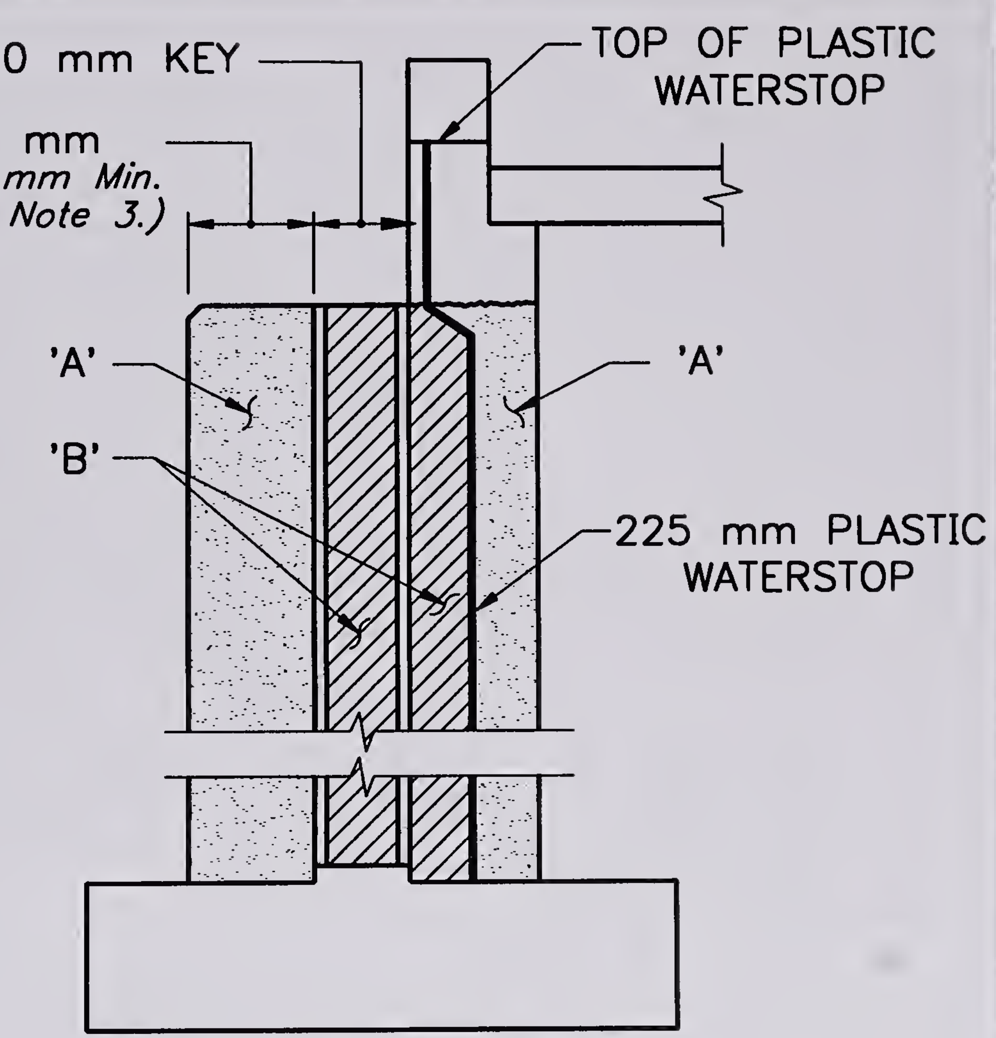
Plot Scale = 1:10

MASS HIGHWAY BRIDGE MANUAL	PREFORMED FILLER IN EXPANSION JOINTS ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.1.10**

Plot Scale = 1:30



GRAVITY ABUTMENT



CANTILEVER ABUTMENT

NOTES:

1. LONGITUDINAL REINFORCEMENT SHALL END 50 mm CLEAR OF EXPANSION JOINT.
2. 'A'–PERFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
   'B'–PREFORMED FILLER (IN ACCORDANCE WITH M3.05.3 BITUMINOUS JOINT FILLER)
3. FILLER MATERIAL SHALL BE FASTENED SECURELY TO ONE SIDE OF JOINT.

VERTICAL SECTION THRU EXPANSION JOINT

NOT TO SCALE

NOTES:

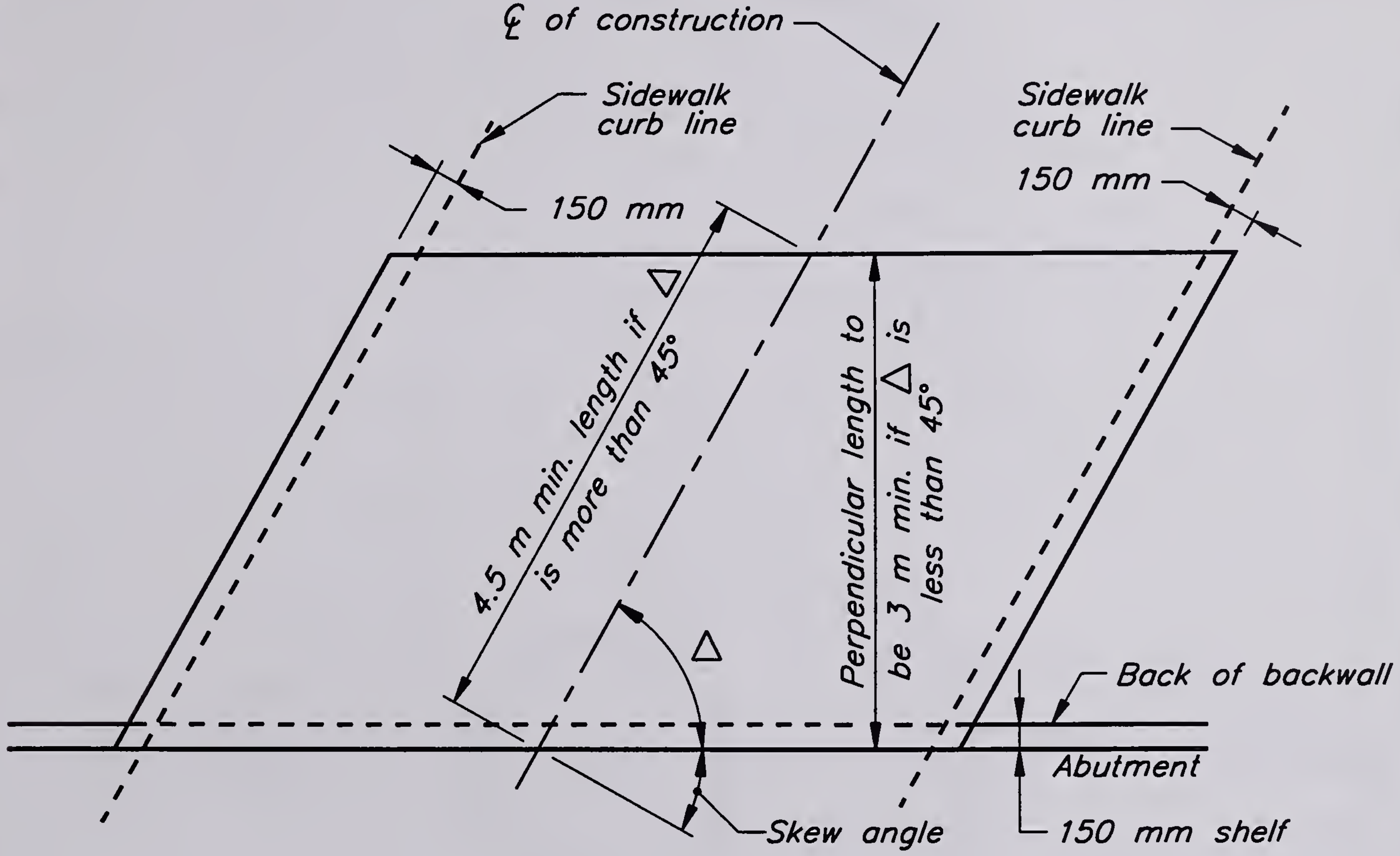
1. *Expansion joints shall be located at intervals not more than 21 m. In the case of long wingwalls, the first joint in the wing from the corner of the abutment is expansion.*
2. *Locate expansion joints by dimensions on the construction plans.*
3. *If 300 mm frontal clearance can not be achieved by placing end of 300 mm key at face of backwall, place key farther back to achieve 300 mm frontal clearance.*

MASS HIGHWAY
BRIDGE
MANUAL

VERTICAL SECTION THRU
EXPANSION JOINT
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.11



PLAN
(NOT TO SCALE)

NOTES:

1. Where angle Δ is greater or equal to 45 : length of 250 mm slab along center line of construction is 4.5 m and main reinforcement is #22 @ 150 mm top and bottom parallel to center line of construction.
2. Where angle Δ is less than 45 : length of 230 mm slab perpendicular to abutment is 3 m minimum and main reinforcement is #19 @ 150 mm top and bottom perpendicular to abutment.
3. If removable panel is used, place steel parallel to center line of construction and design approach slab accordingly.
4. Place #13 @ 450 mm top and bottom parallel to abutment and between main reinforcement.
5. Width of approach slab may have to be reduced if it interferes with utilities.
6. Approach slab to be 30 MPa–40 mm–335 kg cement concrete masonry.
7. Clearances to reinforcement shall be 50 mm.
8. Bituminous Damp–Proofing shall be applied to the top of the approach slab from the end of the membrane waterproofing at the abutment to the end of the approach slab.

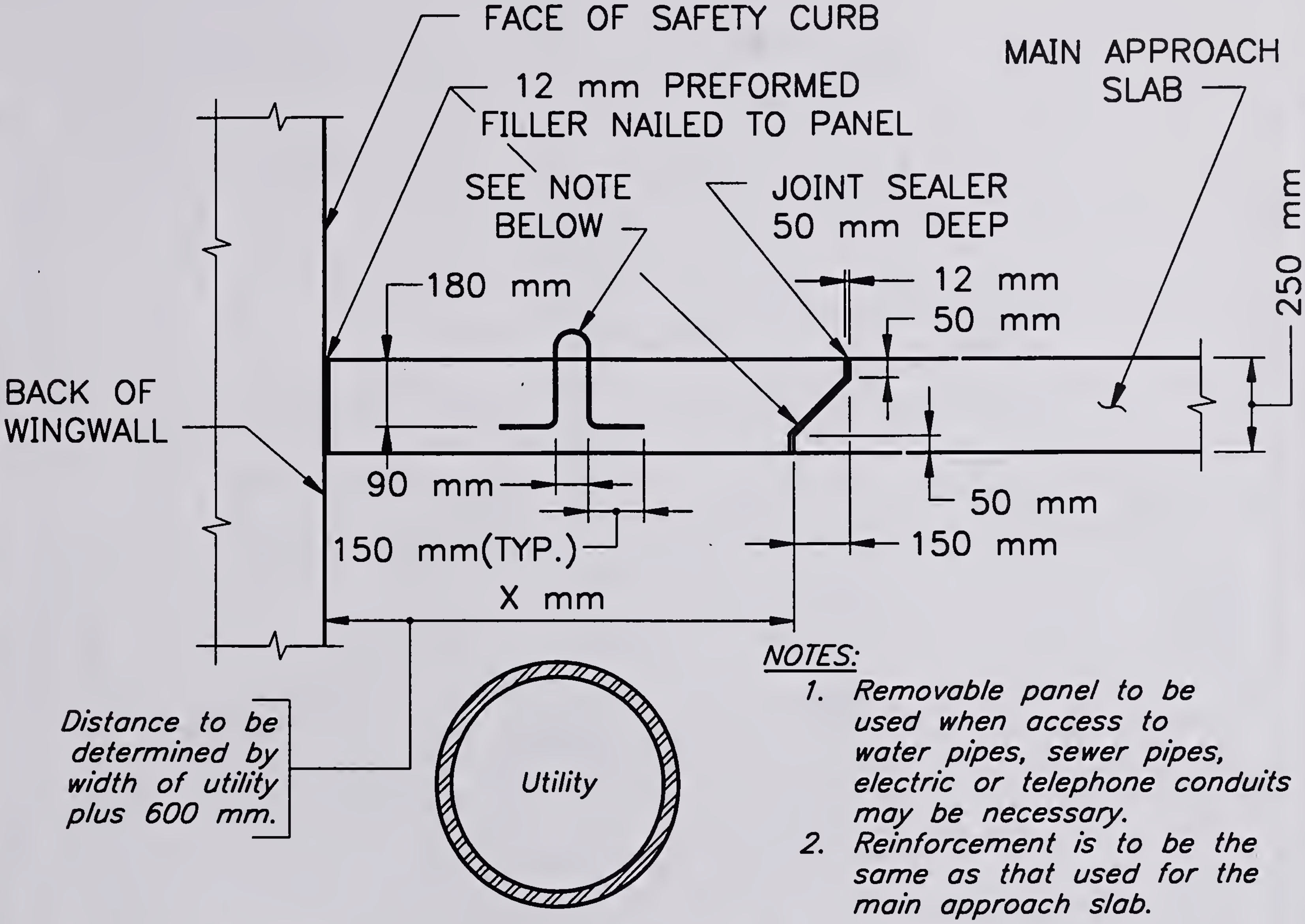
Plot Scale = 1:50

MASS HIGHWAY
BRIDGE
MANUAL

APPROACH SLAB DETAILS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.12



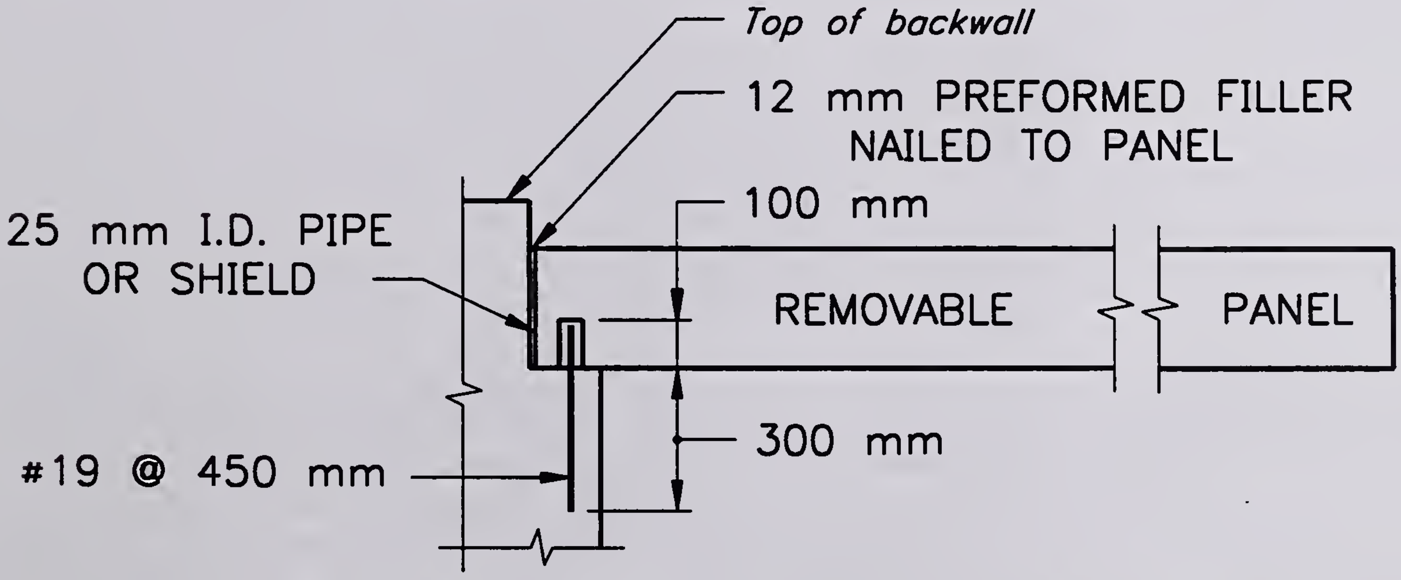
NOTES:

1. *Removable panel to be used when access to water pipes, sewer pipes, electric or telephone conduits may be necessary.*
2. *Reinforcement is to be the same as that used for the main approach slab.*

NOTE: 2 LIFT HOOKS REQUIRED. USE # 16 BAR AT QUARTER POINTS AND PROTECTIVE SEAL COAT EMULSION (2 COATS) ON EXPOSED PART.

SECTION THRU REMOVABLE PANEL

SCALE (1:20 min.)


Top of backwall
12 mm PREFORMED FILLER NAILED TO PANEL
100 mm
25 mm I.D. PIPE OR SHIELD
REMOVABLE
PANEL
300 mm
#19 @ 450 mm

PANEL DETAIL AT ABUTMENT

SCALE 1:20

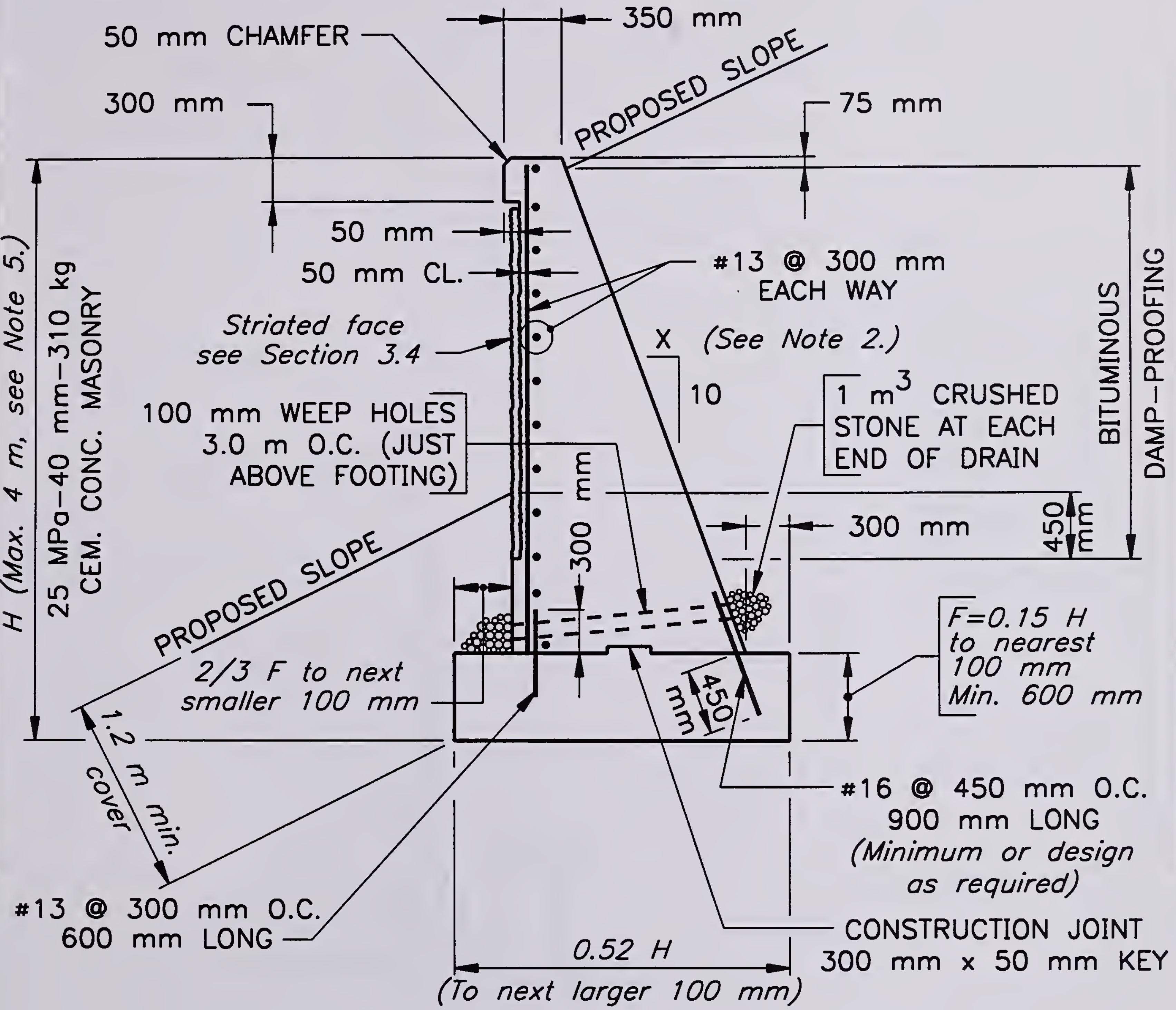
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

REMOVABLE PANEL OF
APPROACH SLAB
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.1.13


50 mm CHAMFER
350 mm
300 mm
PROPOSED SLOPE
75 mm
50 mm
50 mm CL.
#13 @ 300 mm EACH WAY
Striated face see Section 3.4
X (See Note 2.)
10
100 mm WEEP HOLES 3.0 m O.C. (JUST ABOVE FOOTING)
1 m3 CRUSHED STONE AT EACH END OF DRAIN
BITUMINOUS DAMP-PROOFING
H (Max. 4 m, see Note 5.)
25 MPa-40 mm-310 kg CEM. CONC. MASONRY
300 mm
300 mm
450 mm
PROPOSED SLOPE
2/3 F to next smaller 100 mm
450 mm
F=0.15 H to nearest 100 mm Min. 600 mm
1.2 m min. cover
#16 @ 450 mm O.C. 900 mm LONG (Minimum or design as required)
#13 @ 300 mm O.C. 600 mm LONG
CONSTRUCTION JOINT 300 mm x 50 mm KEY
0.52 H (To next larger 100 mm)

TYPICAL SECTION

(FOR RETAINING WALLS OR SPLAYED WINGWALLS)

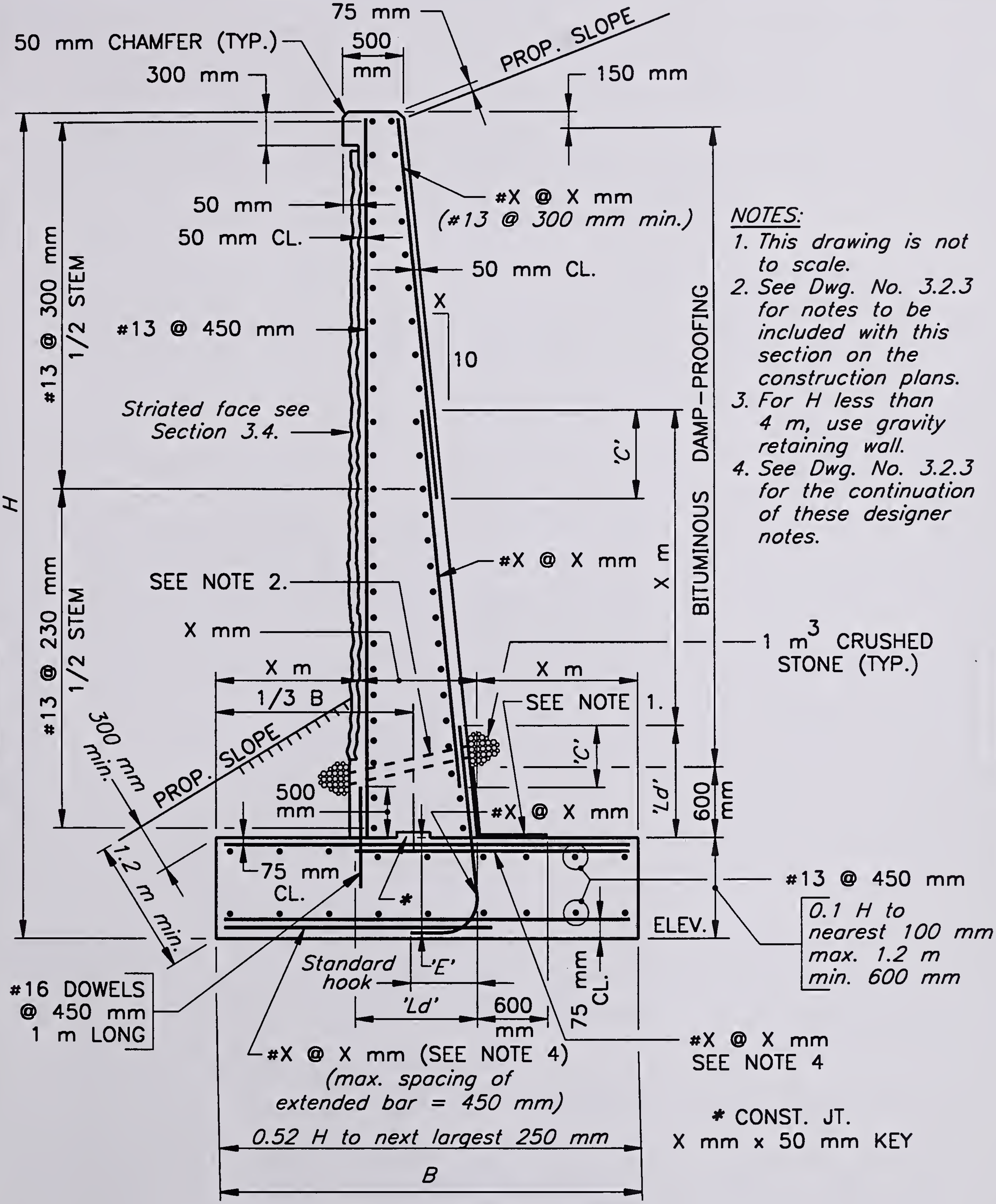
SCALE (1:50 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *The back batter shall be constant and shall be determined by the highest section contained between construction joints.*
3. *Show maximum toe pressure or pile load if on piles.*
4. *If piles are required, see Section 3.6.*
5. *Footing to be omitted when founded on ledge, for typical section see Dwg. No. 3.6.4. H may be increased to 7 m.*
6. *Design base width including any live load surcharge and include the effects of sloping backfills where applicable.*

Plot Scale = 1:45

MASSHIGHWAY BRIDGE MANUAL	TYPICAL GRAVITY RETAINING WALL SECTION WINGWALL DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.2.1**



NOTES:

1. *This drawing is not to scale.*
2. *See Dwg. No. 3.2.3 for notes to be included with this section on the construction plans.*
3. *For H less than 4 m, use gravity retaining wall.*
4. *See Dwg. No. 3.2.3 for the continuation of these designer notes.*

TYPICAL SECTION
(FOR RETAINING WALLS OR SPLAYED WINGWALLS)

SCALE (1:50 min.)

Plot Scale = 1:50

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL CANTILEVER RETAINING
WALL SECTION
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.2

NOTES: *(Include these notes with section shown on Dwg. No. 3.2.2)*

1. MEMBRANE WATERPROOFING AND 200 mm x 400 mm x 50 mm, 30 MPa–20 mm–390 kg CEMENT CONCRETE MASONRY BLOCKS LAID IN MORTAR OR OTHER WATERPROOFING PROTECTIVE COURSE, MIN. 50 mm THICK AS SPECIFIED IN M.H.D. STANDARD SPECIFICATIONS.
2. 100 mm WEEP HOLES 3 m O.C. (JUST ABOVE PROTECTIVE COURSE).
3. ALL CONCRETE SHALL BE 30 MPa–40 mm–335 kg CEMENT CONCRETE MASONRY.
4. EXTEND EVERY THIRD BAR FULL LENGTH AS SHOWN.
5. MAXIMUM SOIL PRESSURE = XXXX kPa.

NOTES: (Continued from Dwg. No. 3.2.2)

5. *Reinforcing steel in back of wall shall be designed for bending and direct stress and shall conform to AASHTO M31 Grade 400.*
6. *Provide adequate lap lengths 'C', embedment lengths 'L_d', and hook embedment lengths 'E'.*
7. *Where piles are used, see Section 3.6.*
8. *Increase cover by 25 mm where concrete is exposed to salt water.*
9. *Design base width including any live load surcharge and include the effects of sloping backfill.*
10. *Where design height H is greater than 9.0 m, consider a counterfort design.*
11. *Where height of walls H, varies between construction or expansion joints, the design of that segment of retaining wall may be based on the geometry of a section taken thru the 1/4 point of the segment adjacent to the highest end of the wall.*
12. *Provide adequate 'L_d' for toe and heel steel rebars and extend every third rebar full length.*

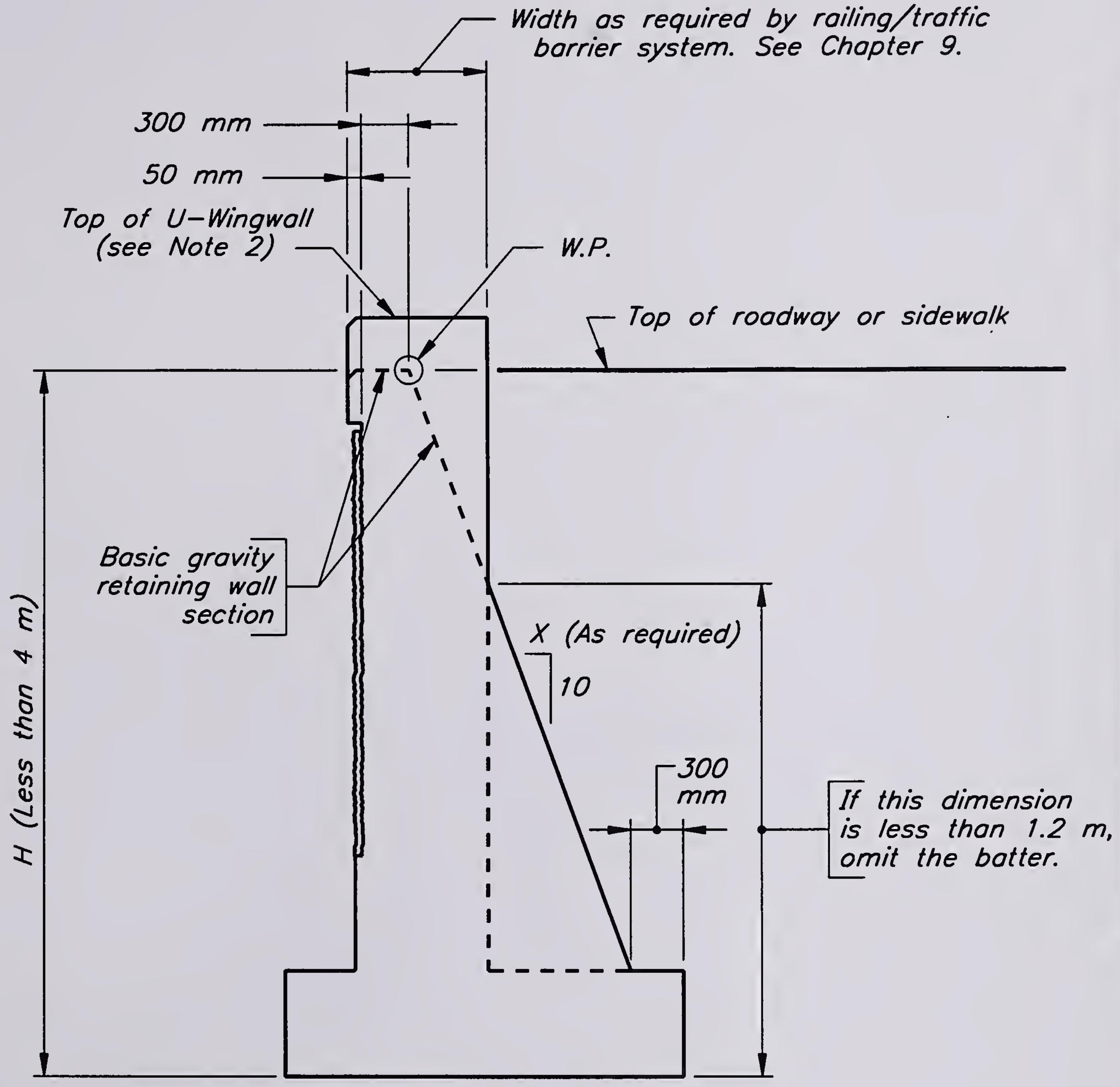
Plot Scale = 1:1

MASS HIGHWAY
BRIDGE MANUAL

CONSTRUCTION NOTES FOR
CANTILEVER RETAINING WALL
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.3


Width as required by railing/traffic barrier system. See Chapter 9.
300 mm
50 mm
Top of U-Wingwall (see Note 2)
W.P.
Top of roadway or sidewalk
Basic gravity retaining wall section
H (Less than 4 m)
X (As required)
10
300 mm
If this dimension is less than 1.2 m, omit the batter.

TYPICAL GEOMETRY

NOT TO SCALE

NOTES:

1. For the Typical Section through a gravity U-wingwall, see Dwg. No. 3.2.1 and modify the geometry as shown above and as specified in Note 2 below.
2. The top of U-wingwall may fall above or below the top of roadway depending on the type of railing/traffic barrier system. See Top of U-Wingwall Details shown in Chapter 9 under the appropriate railing. Match any construction joints and additional reinforcement shown in the detail.

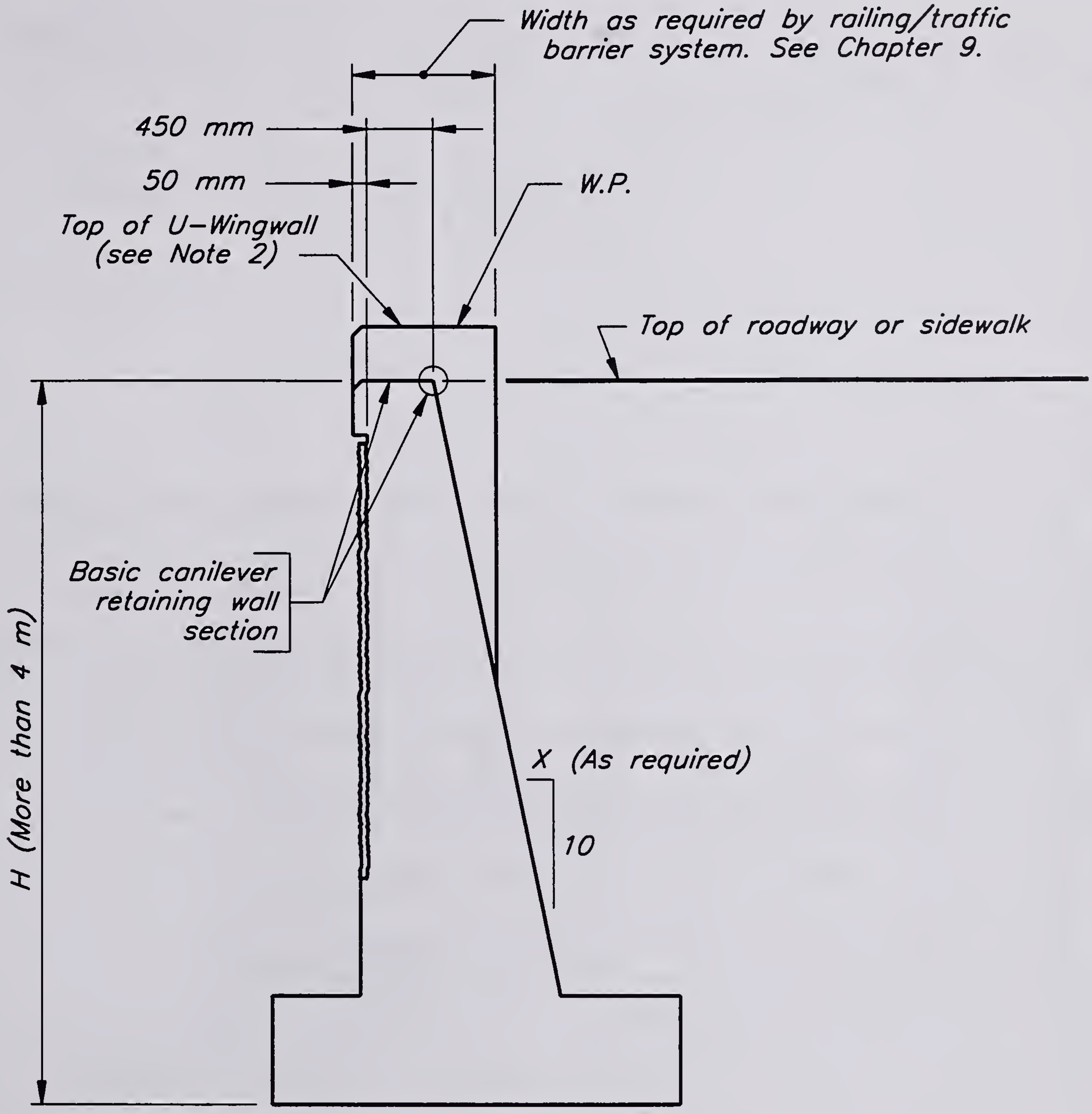
Plot Scale = 1:40

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR GRAVITY
U-WINGWALL
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.4



Width as required by railing/traffic barrier system. See Chapter 9.
450 mm
50 mm
W.P.
Top of U-Wingwall (see Note 2)
Top of roadway or sidewalk
Basic canilever retaining wall section
H (More than 4 m)
X (As required)
10

TYPICAL GEOMETRY

NOT TO SCALE

NOTES:

1. For the Typical Section through a cantilever U–wingwall, see Dwg. No. 3.2.2 and modify the geometry as shown above and as specified in Note 2 below.
2. The top of U–wingwall may fall above or below the top of roadway depending on the type of railing/traffic barrier system. See Top of U–Wingwall Details shown in Chapter 9 under the appropriate railing. Match any construction joints and additional reinforcement shown in the detail.

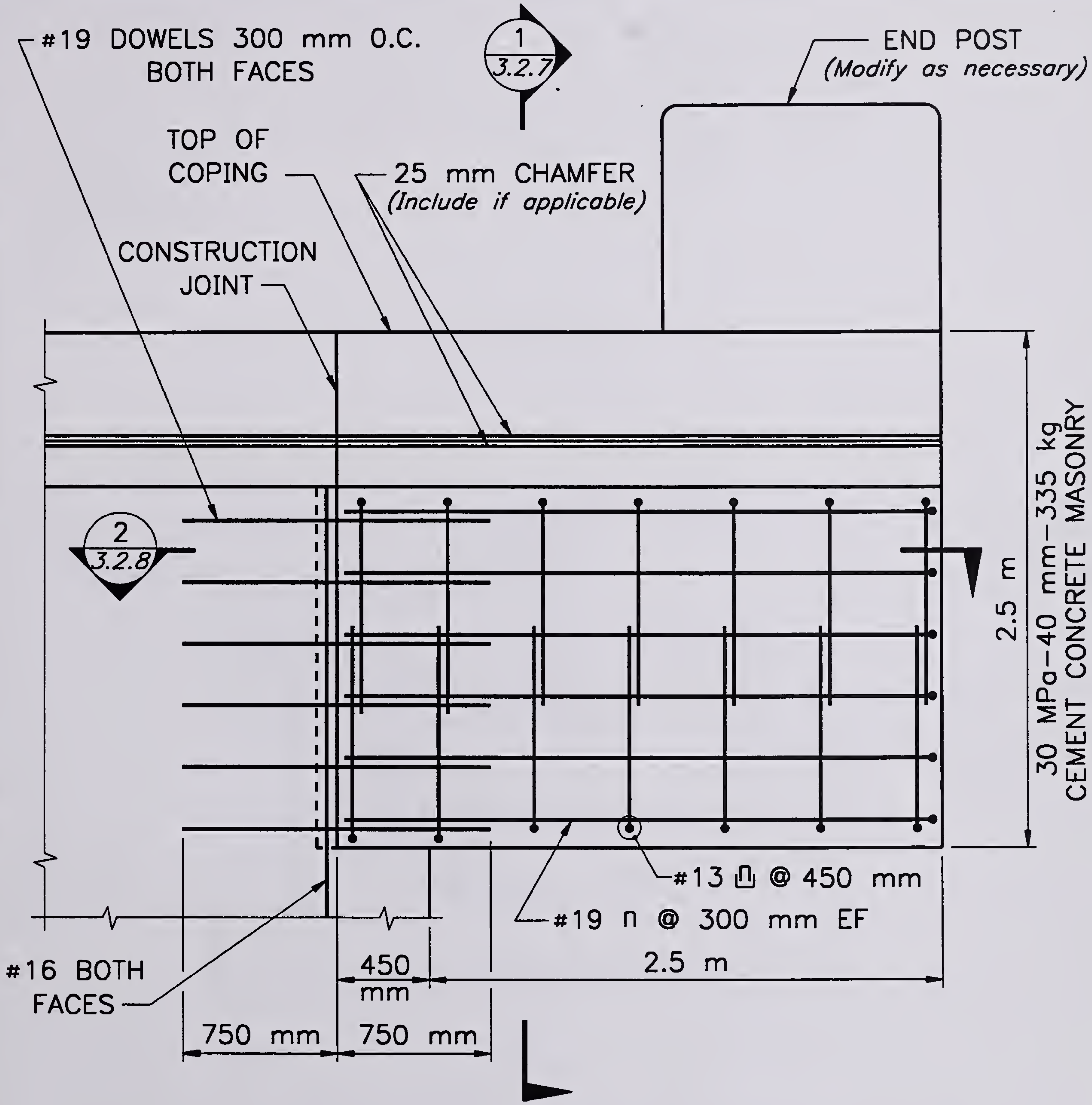
Plot Scale = 1:40

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR CANTILEVER
U–WINGWALL
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.5



NOTES:

1. FILL SHALL BE PLACED AND THOROUGHLY COMPACTED TO THE GRADE OF THE BOTTOM OF THE WINGS; OR WHERE NO FILL IS REQUIRED BELOW THE WINGS, THE CONCRETE SHALL BE PLACED ON UNDISTURBED SOIL.
2. STRIATIONS NOT SHOWN FOR CLARITY.

ELEVATION OF FLYING WINGWALL

SCALE (1:25 min.)

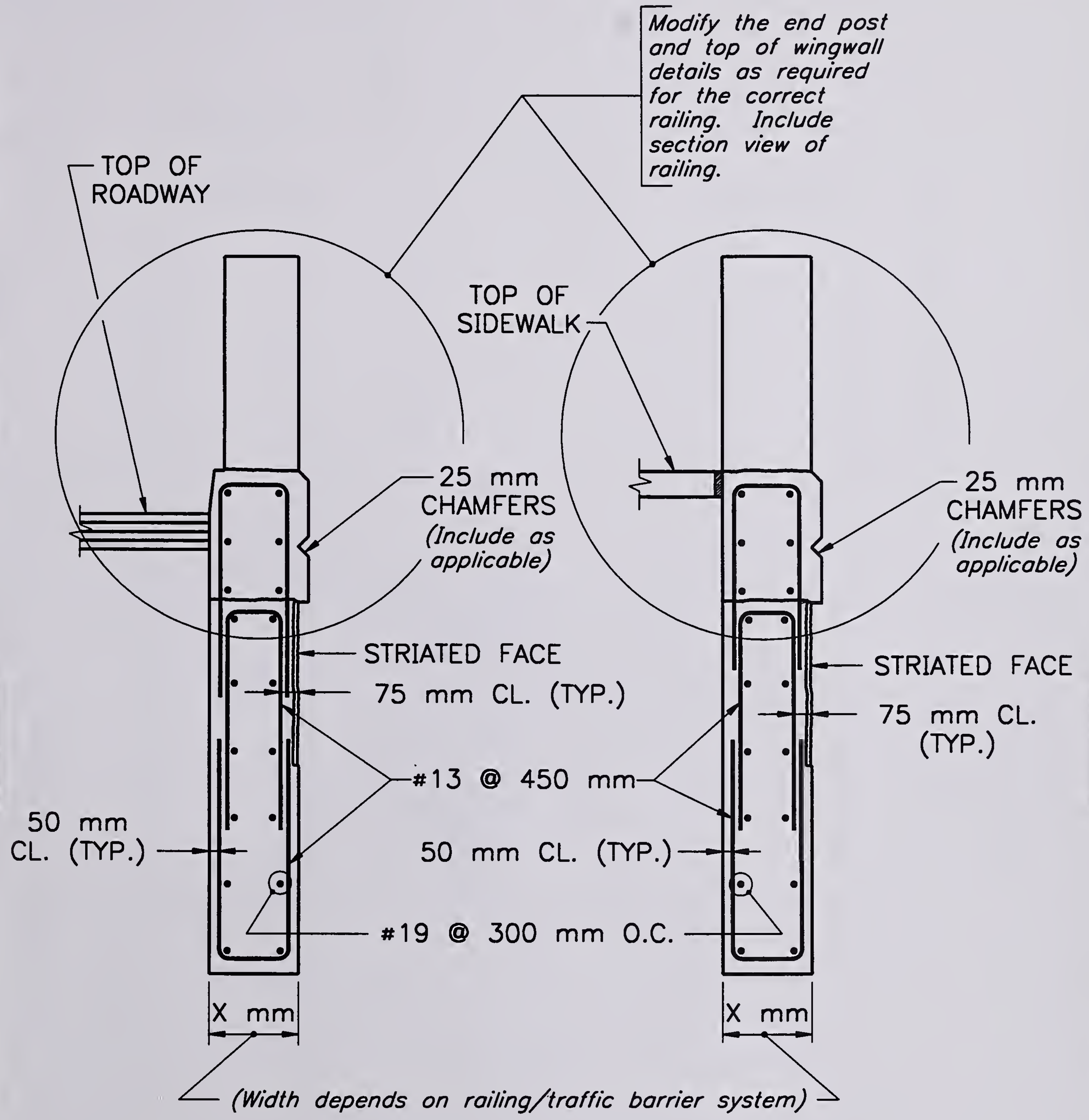
Plot Scale = 1:30

MASS HIGHWAY
BRIDGE
MANUAL

FLYING WINGWALL ELEVATION
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.6


Modify the end post and top of wingwall details as required for the correct railing. Include section view of railing.
TOP OF ROADWAY
TOP OF SIDEWALK
25 mm CHAMFERS (Include as applicable)
25 mm CHAMFERS (Include as applicable)
STRIATED FACE
STRIATED FACE
75 mm CL. (TYP.)
75 mm CL. (TYP.)
#13 @ 450 mm
50 mm CL. (TYP.)
50 mm CL. (TYP.)
#19 @ 300 mm O.C.
X mm
X mm
(Width depends on railing/traffic barrier system)

SECTION 1
SAFETY CURB SIDE
SCALE (1:25 min.)

SECTION 1
SIDEWALK SIDE
SCALE (1:25 min.)

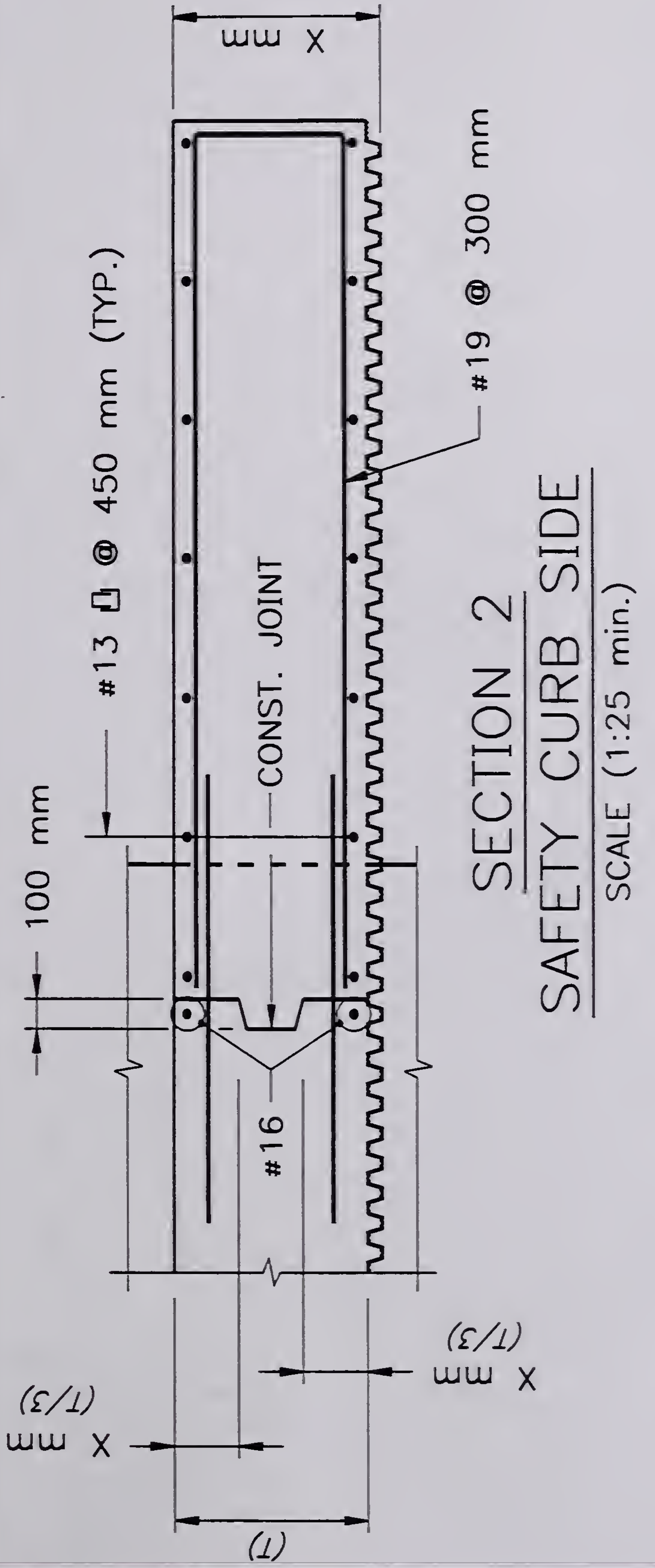
Plot Scale = 1:30

MASS HIGHWAY
BRIDGE MANUAL

FLYING WINGWALL
VERTICAL SECTIONS
WINGWALL DETAILS

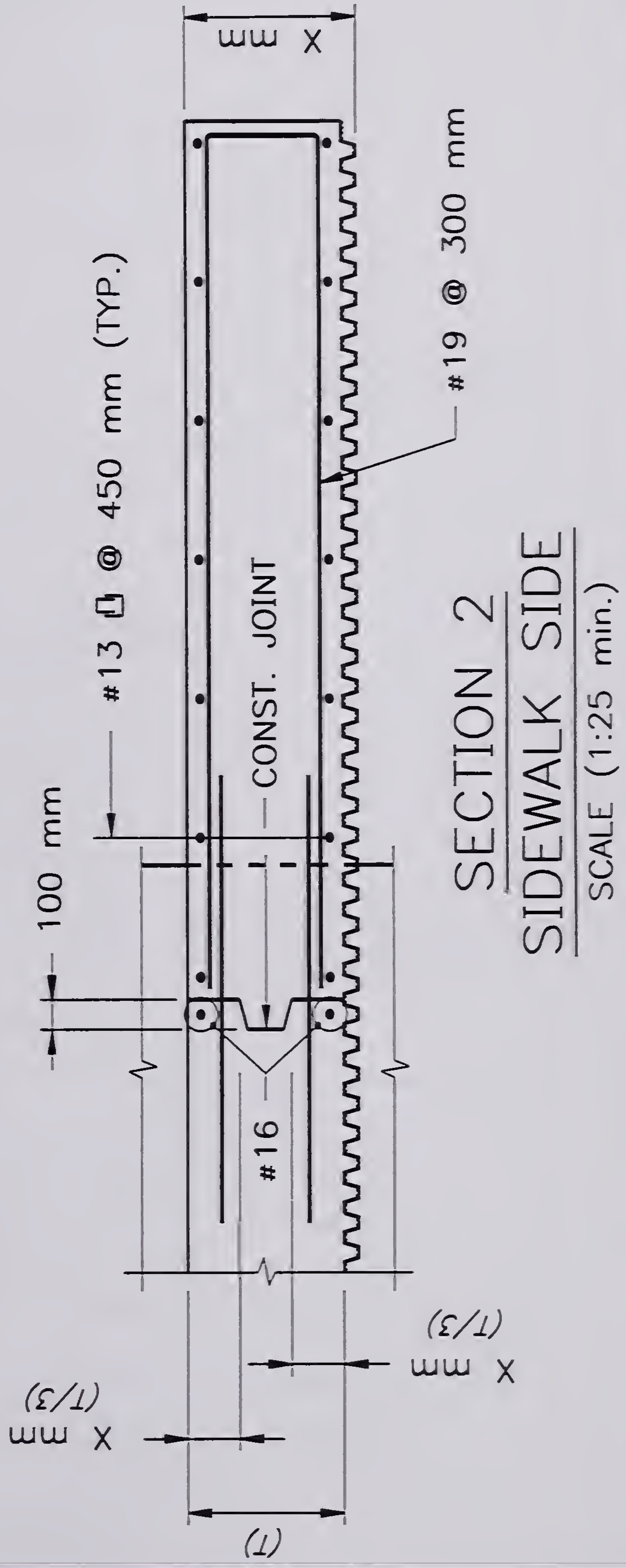
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.7



SECTION 2
SAFETY CURB SIDE

SCALE (1:25 min.)



SECTION 2
SIDEWALK SIDE

SCALE (1:25 min.)

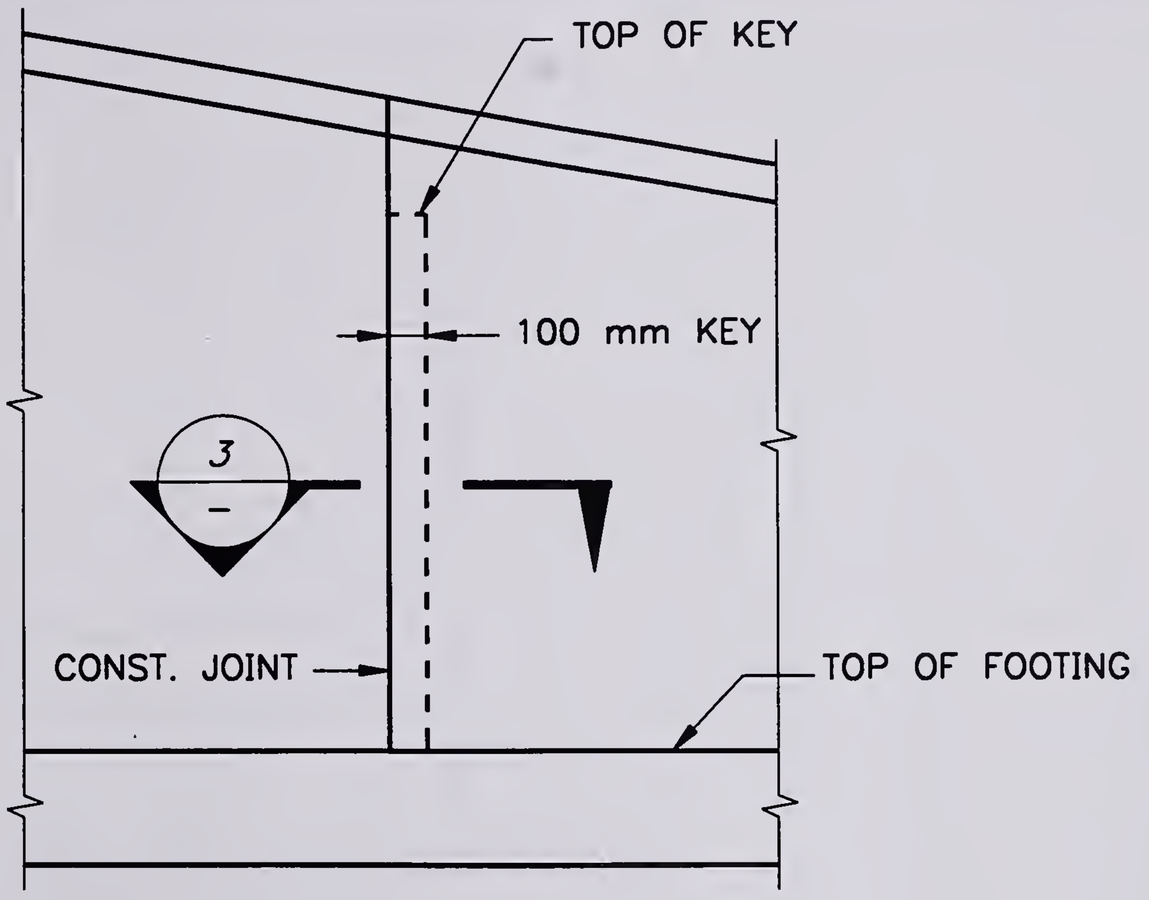
Plot Scale = 1:25

MASS HIGHWAY
BRIDGE
MANUAL

FLYING WINGWALL
HORIZONTAL SECTIONS
WINGWALL DETAILS

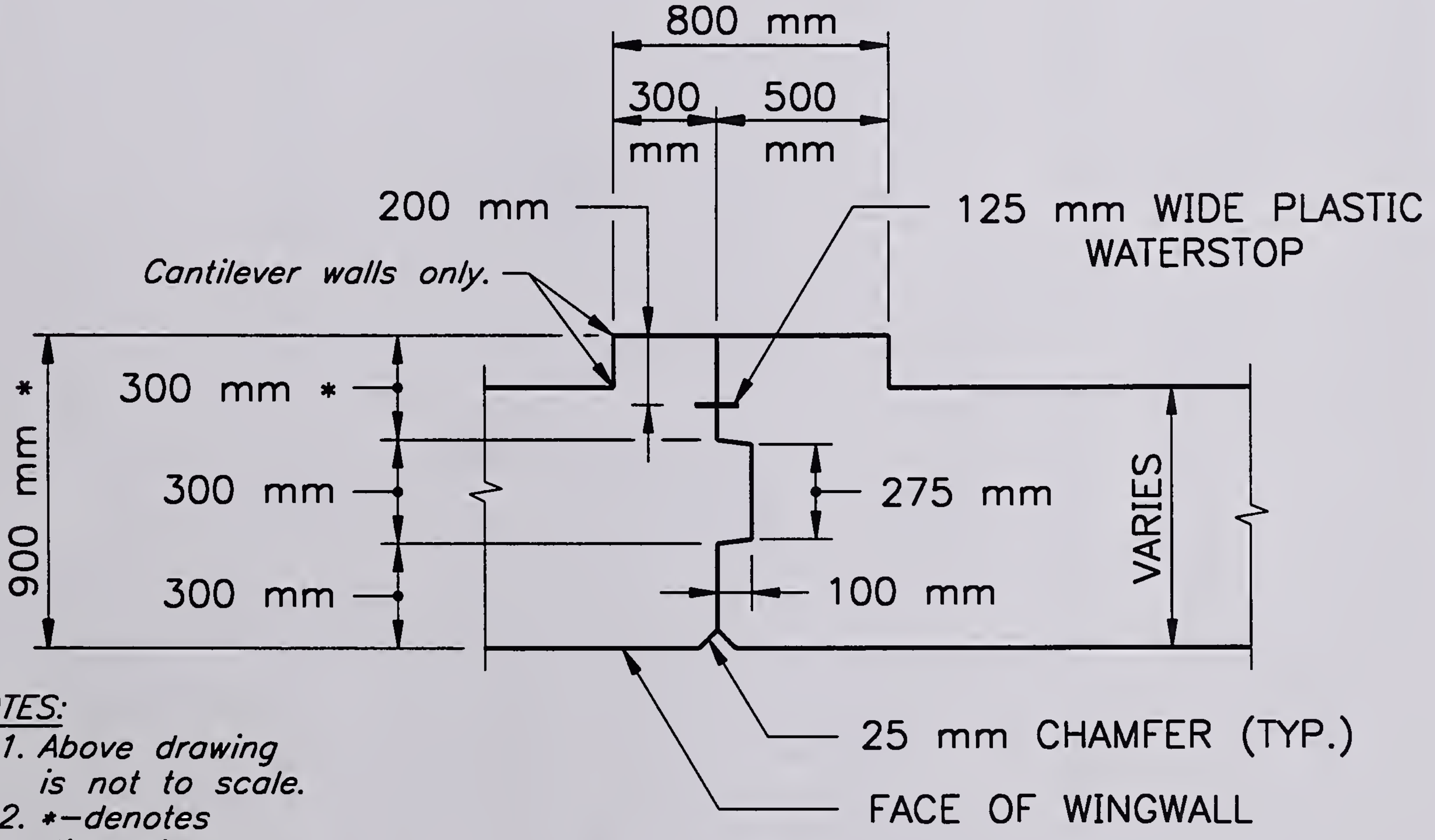
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.8



ELEVATION OF WINGWALL

NOT TO SCALE



NOTES:

1. *Above drawing is not to scale.*
2. **–denotes dimension that varies for gravity wall.*
3. *Alter as required for striated face.*

SECTION 3

SCALE (1:25 min.)

Plot Scale = 1:25

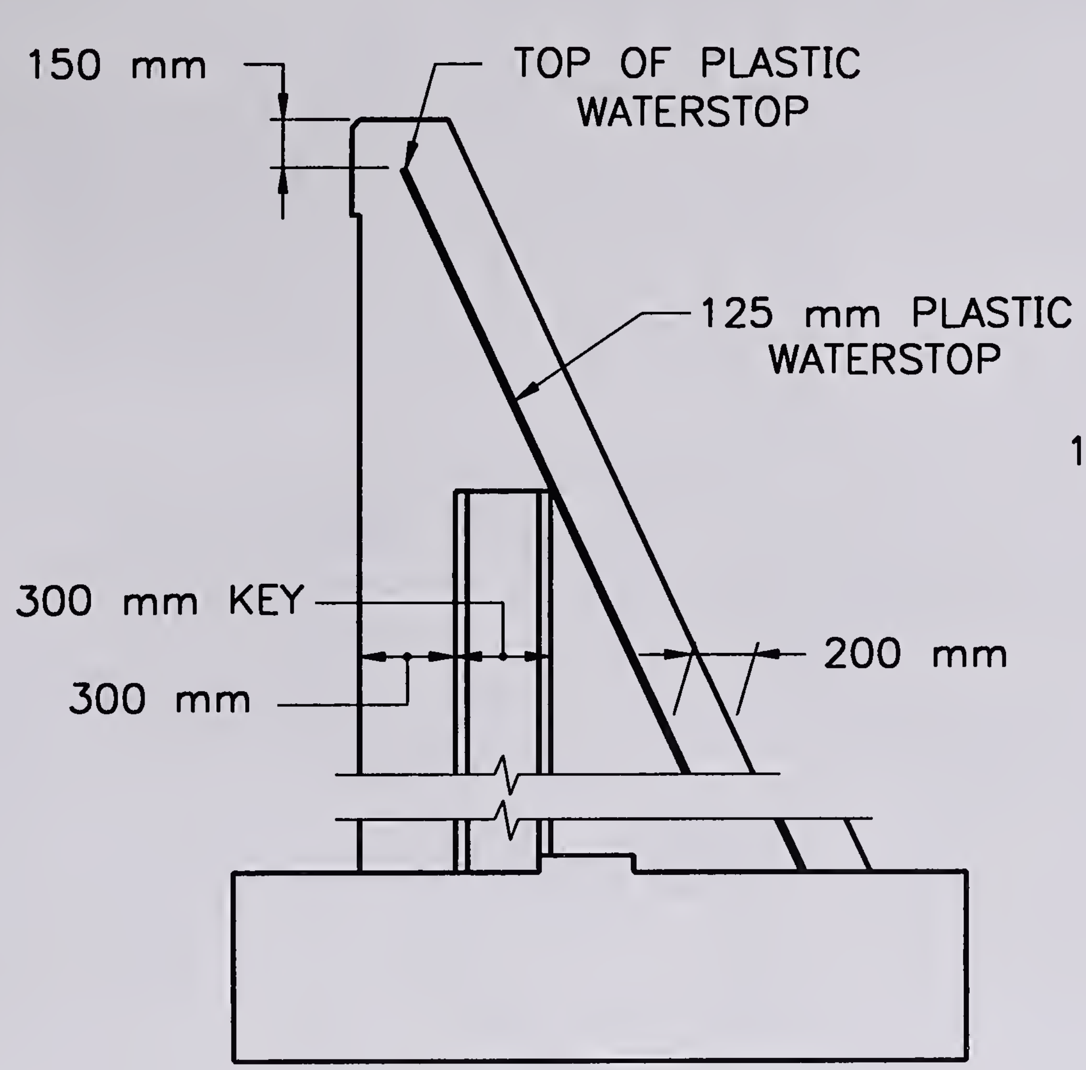
MASS HIGHWAY
BRIDGE MANUAL

CONSTRUCTION JOINT DETAILS
WINGWALL DETAILS

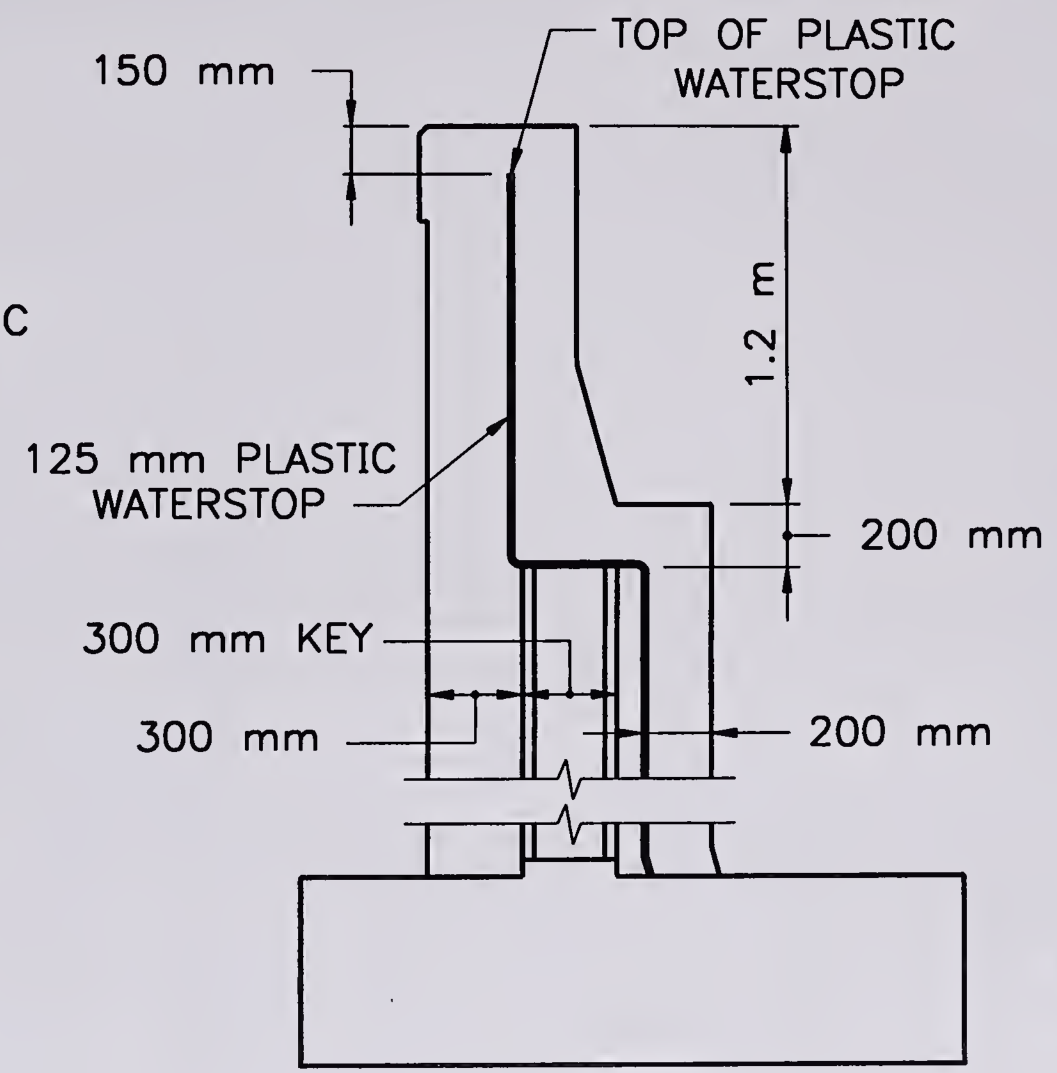
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.9

Plot Scale = 1:30



GRAVITY WINGWALL



CANTILEVER WINGWALL

NOTE: REINFORCEMENT SHALL BE CONTINUOUS THRU CONSTRUCTION JOINTS.

VERTICAL SECTION THRU CONSTRUCTION JOINT

NOT TO SCALE

NOTES:

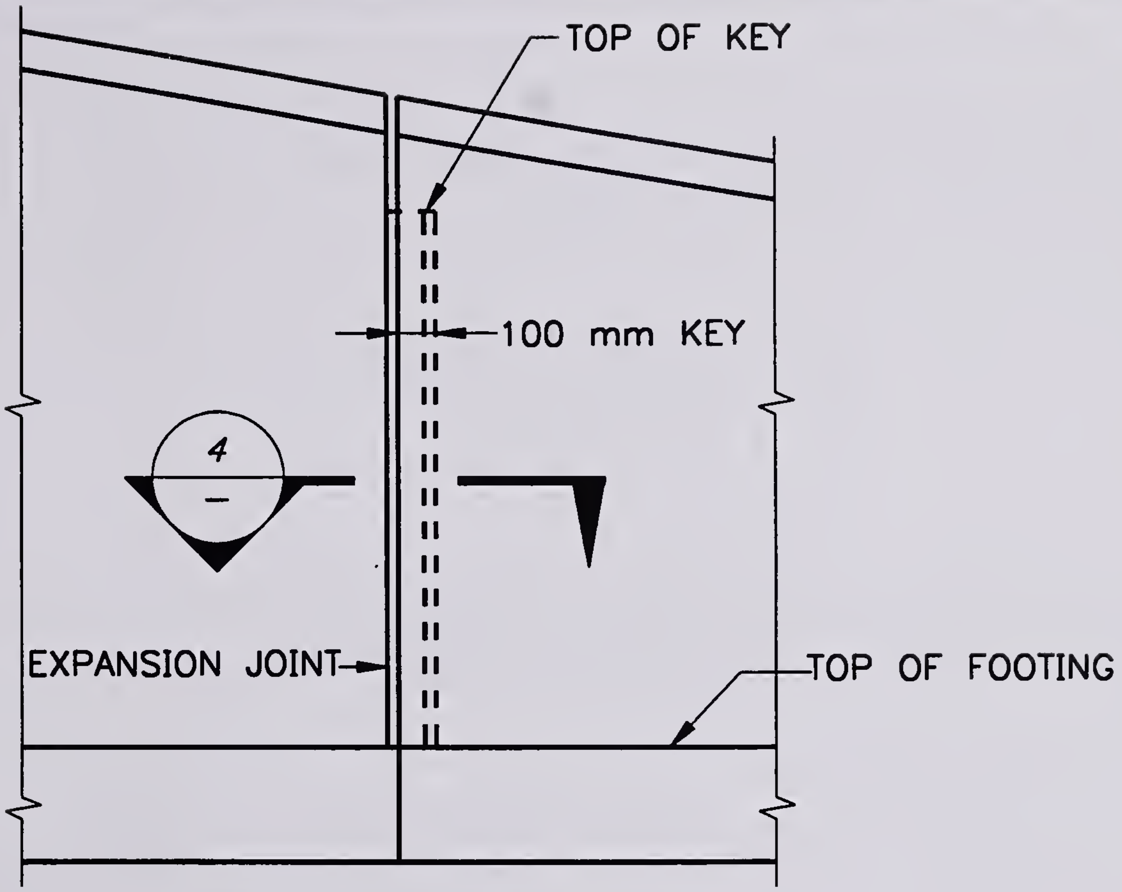
1. *Construction joints shall be located at intervals of not more than 7 m.*
2. *Locate construction joints by dimensions on construction plans.*

MASS HIGHWAY
BRIDGE
MANUAL

VERTICAL SECTION THRU
CONSTRUCTION JOINT
WINGWALL DETAILS

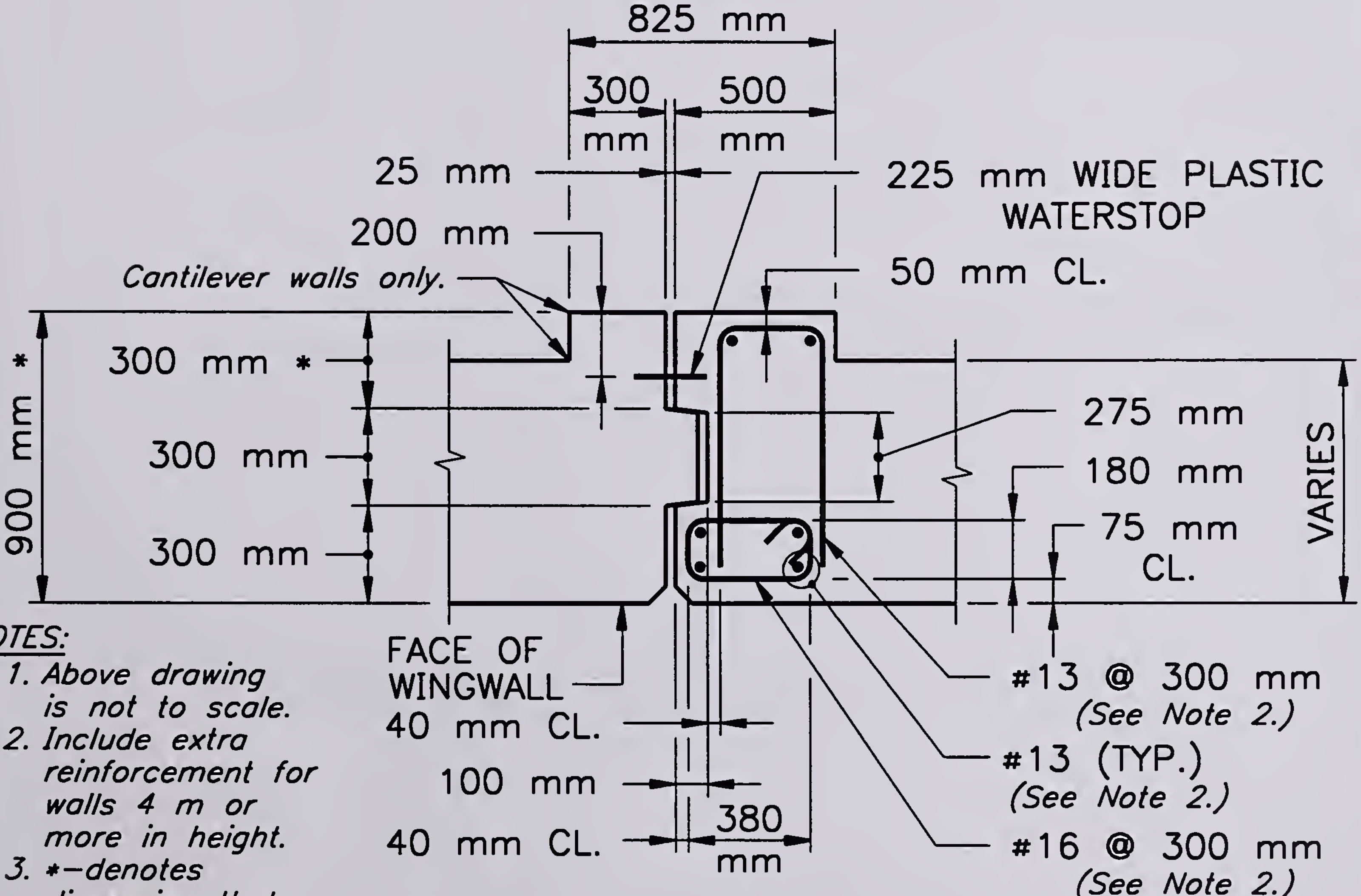
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.10



ELEVATION OF WINGWALL

NOT TO SCALE



SECTION 4

SCALE (1:25 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *Include extra reinforcement for walls 4 m or more in height.*
3. **–denotes dimension that varies for gravity wall.*
4. *Alter as required for striated face.*

Plot Scale = 1:25

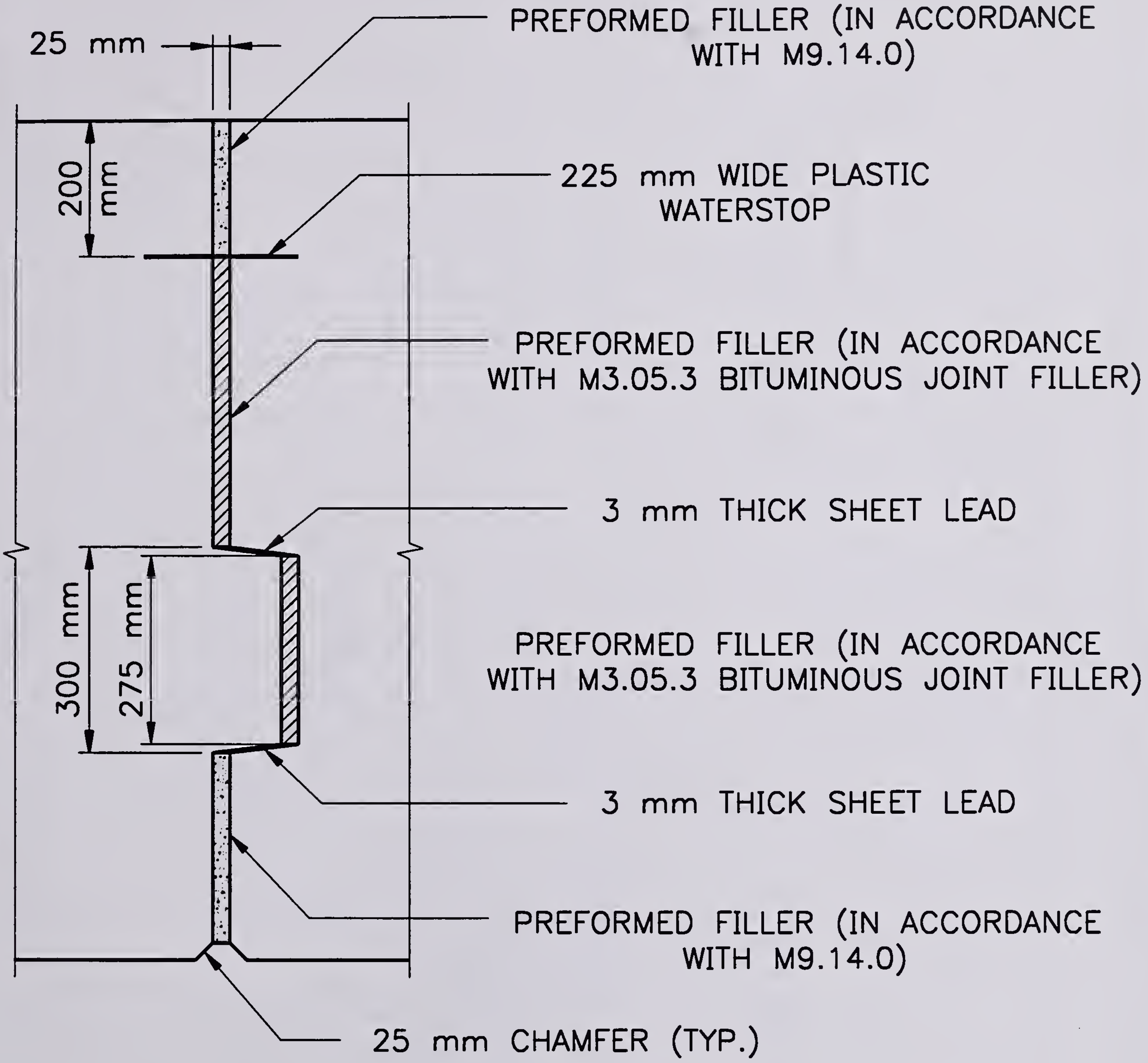
MASS HIGHWAY
BRIDGE MANUAL

EXPANSION JOINT DETAILS

WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.11


PREFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
25 mm
200 mm
225 mm WIDE PLASTIC WATERSTOP
PREFORMED FILLER (IN ACCORDANCE WITH M3.05.3 BITUMINOUS JOINT FILLER)
3 mm THICK SHEET LEAD
300 mm
275 mm
PREFORMED FILLER (IN ACCORDANCE WITH M3.05.3 BITUMINOUS JOINT FILLER)
3 mm THICK SHEET LEAD
PREFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
25 mm CHAMFER (TYP.)

LIMITS OF PREFORMED FILLER

SCALE 1:10

NOTE: Alter as required for striated face.

Plot Scale = 1:10

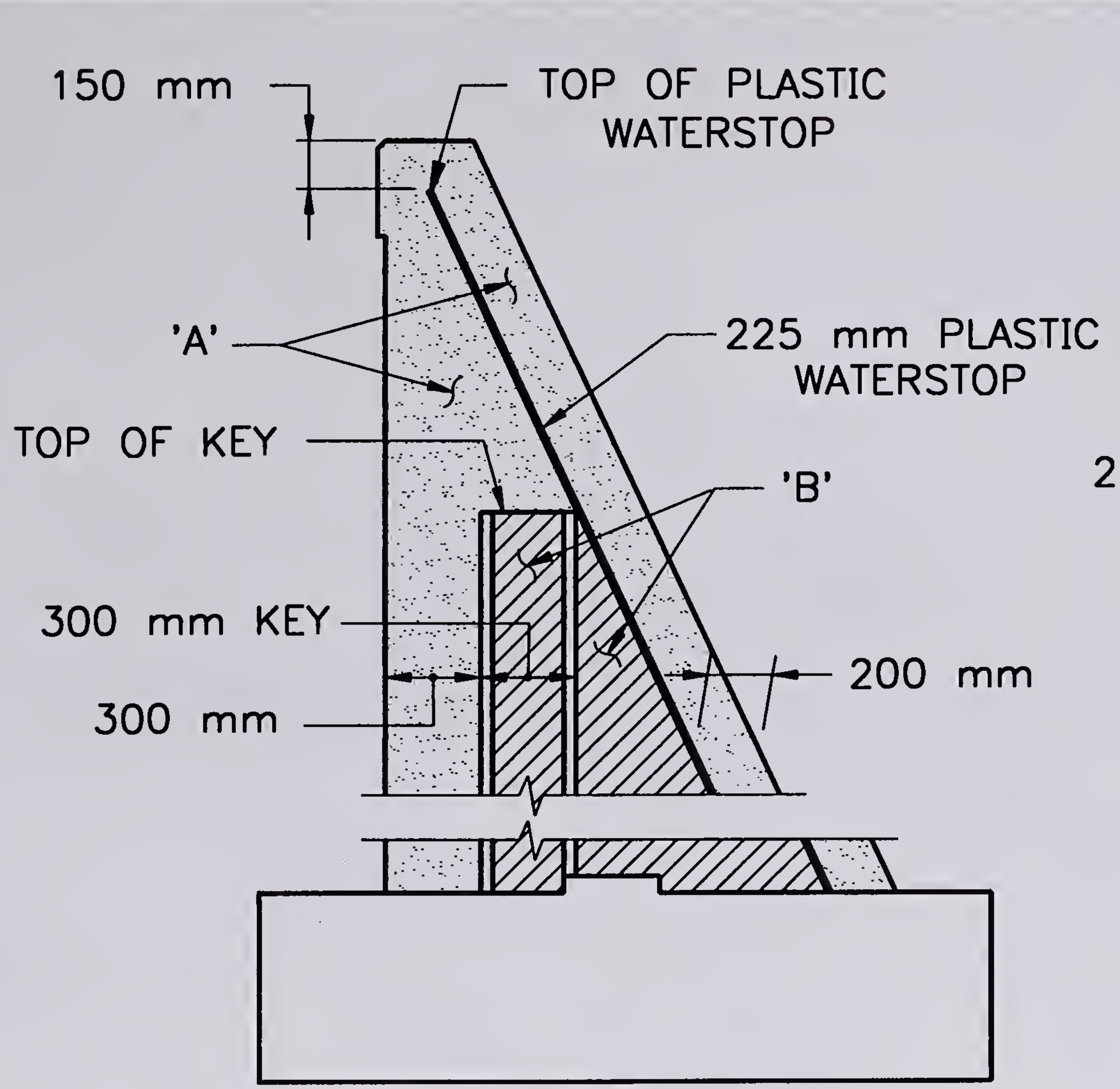
MASS HIGHWAY
BRIDGE
MANUAL

PREFORMED FILLER IN
EXPANSION JOINTS
WINGWALL DETAILS

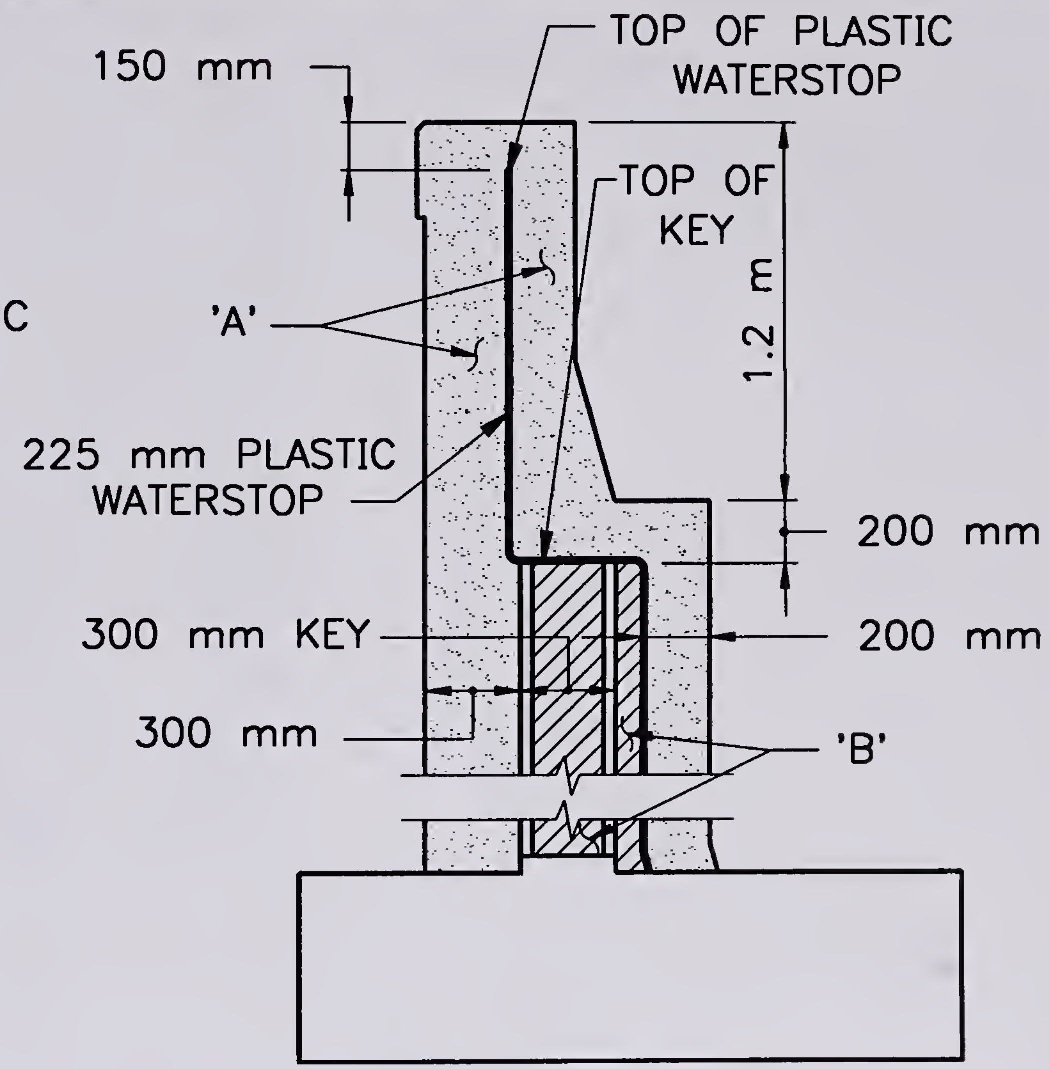
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.12

Plot Scale = 1:30



GRAVITY WINGWALL



CANTILEVER WINGWALL

NOTES:

1. LONGITUDINAL REINFORCEMENT SHALL END 50 mm CLEAR OF EXPANSION JOINT.
2. 'A'–PERFORMED FILLER (IN ACCORDANCE WITH M9.14.0)
   'B'–PREFORMED FILLER (IN ACCORDANCE WIHT M3.05.3 BITUMINOUS JOINT FILLER)
3. FILLER MATERIAL SHALL BE FASTENED SECURELY TO ONE SIDE OF JOINT.

VERTICAL SECTION THRU EXPANSION JOINT

NOT TO SCALE

NOTES:

1. *Expansion joints shall be located at intervals not more than 21 m. In the case of long wingwalls, the first joint in the wing from the corner of the abutment is expansion.*
2. *Locate expansion joints by dimensions on the construction plans.*

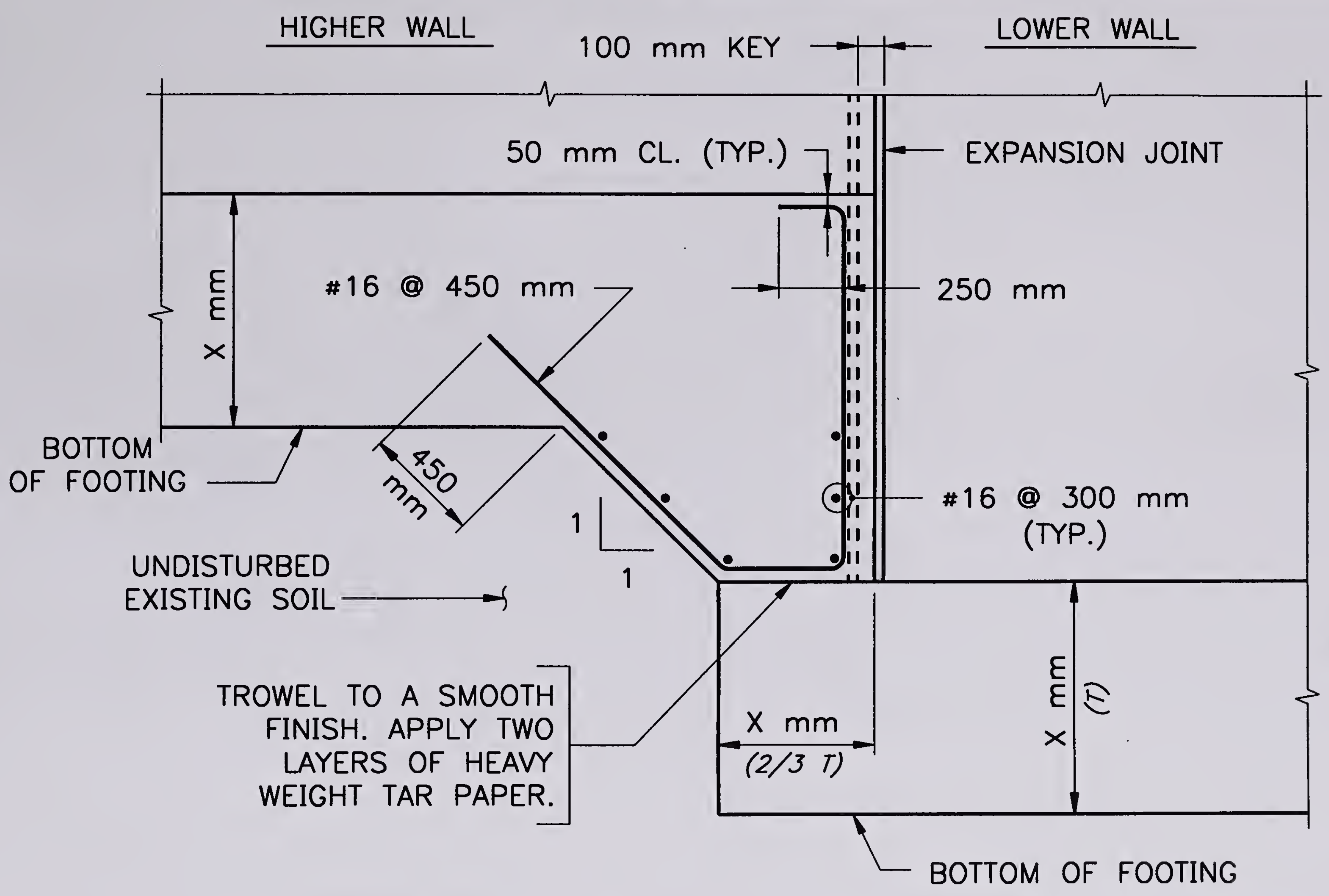
MASS HIGHWAY
BRIDGE
MANUAL

VERTICAL SECTION THRU
EXPANSION JOINT
WINGWALL DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.2.13

Plot Scale = 1:25



STEPPED-UP FOOTING DETAIL

SCALE (1:25 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *This detail may be used for cantilever or gravity walls or a combination of cantilever and gravity walls.*
3. *Height of step from bottom of higher footing to bottom of lower footing shall not be excessive. A step height of about 1.5 m is reasonable.*

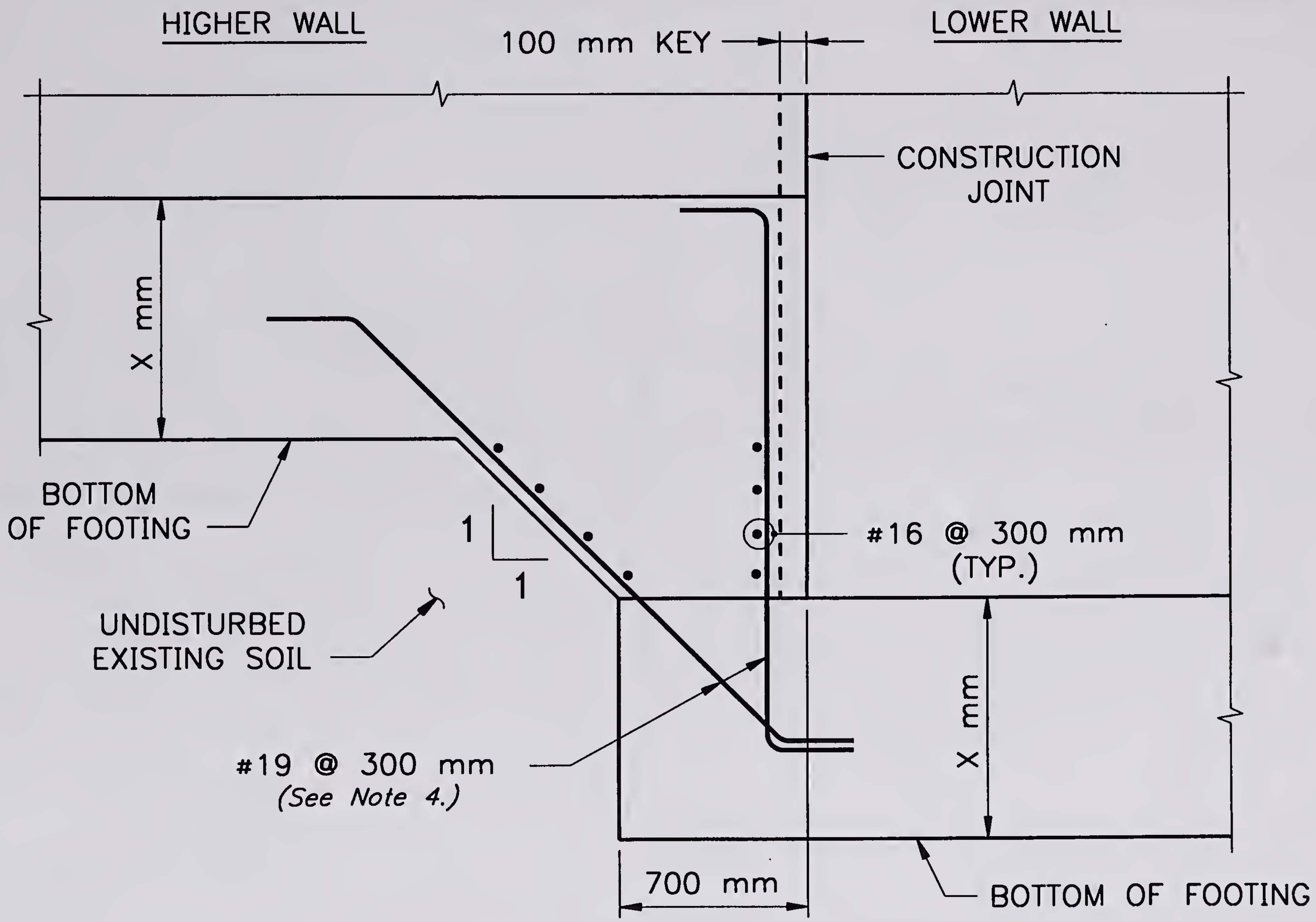
MASSHIGHWAY
BRIDGE
MANUAL

EXPANSION JOINT AT STEP
STEPPED-UP FOOTINGS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.3.1

Plot Scale = 1:25



STEPPED-UP FOOTING DETAIL

SCALE (1:25 min.)

NOTES:

1. *Above drawing is not to scale.*
2. *This detail may be used for cantilever or gravity walls or a combination of cantilever and gravity walls.*
3. *Height of step from bottom of higher footing to bottom of lower footing shall not be excessive. A step height of about 1.5 m is reasonable.*
4. *Provide proper embedment lengths and clearances for #19 @ 300 mm on the plans.*

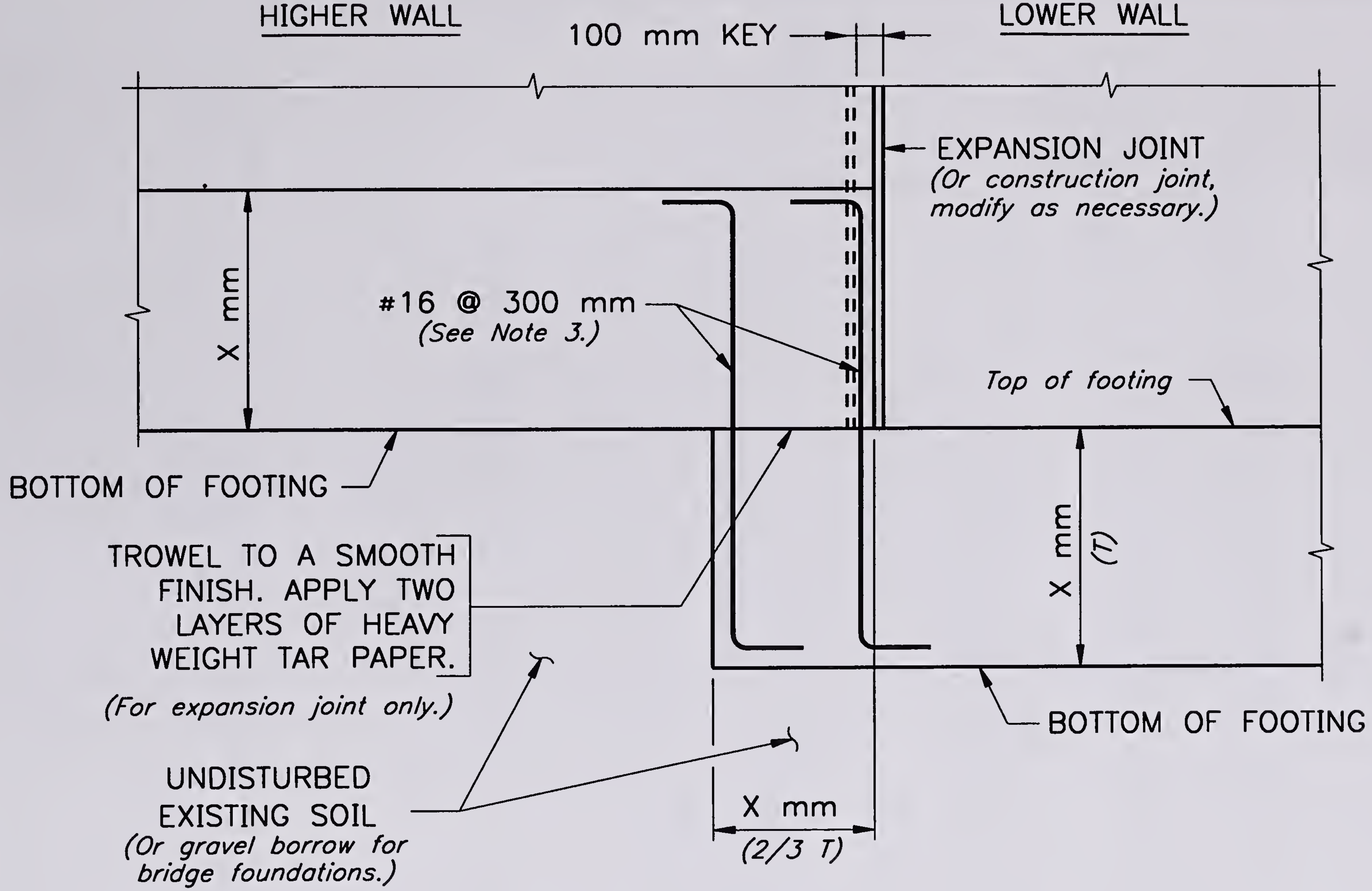
MASSHIGHWAY
BRIDGE
MANUAL

CONSTRUCTION JOINT AT STEP
STEPPED-UP FOOTINGS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.3.2

Plot Scale = 1:25


HIGHER WALL
100 mm KEY
LOWER WALL
EXPANSION JOINT
(Or construction joint, modify as necessary.)
X mm
#16 @ 300 mm
(See Note 3.)
Top of footing
BOTTOM OF FOOTING
X mm
(T)
TROWEL TO A SMOOTH FINISH. APPLY TWO LAYERS OF HEAVY WEIGHT TAR PAPER.
(For expansion joint only.)
BOTTOM OF FOOTING
UNDISTURBED EXISTING SOIL
(Or gravel borrow for bridge foundations.)
X mm
(2/3 T)

STEPPED-UP FOOTING DETAIL

SCALE (1:25 min.)

NOTES:

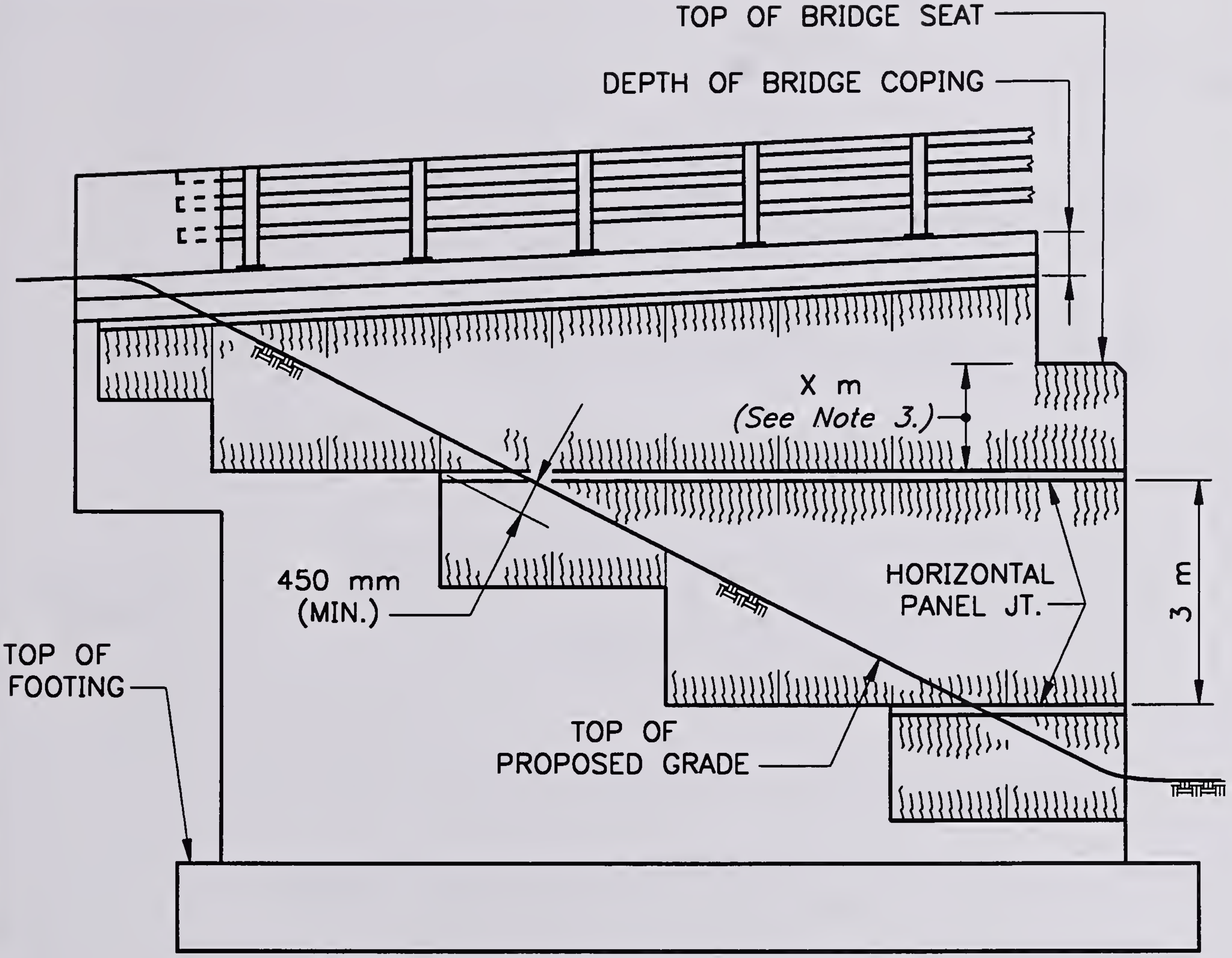
1. Above drawing is not to scale.
2. This detail may be used for cantilever or gravity walls or a combination of cantilever and gravity walls.
3. For construction joints only, include #16 @ 300 mm bars trough stepped-up section when cantilever walls are used. Provide proper embedment lengths on the plans.

MASS HIGHWAY
BRIDGE
MANUAL

UPPER FOOTING ON LOWER
FOOTING
STEPPED-UP FOOTINGS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.3.3



NOTE: HORIZONTAL PANEL JOINTS SHALL BE LEVEL.

ELEVATION

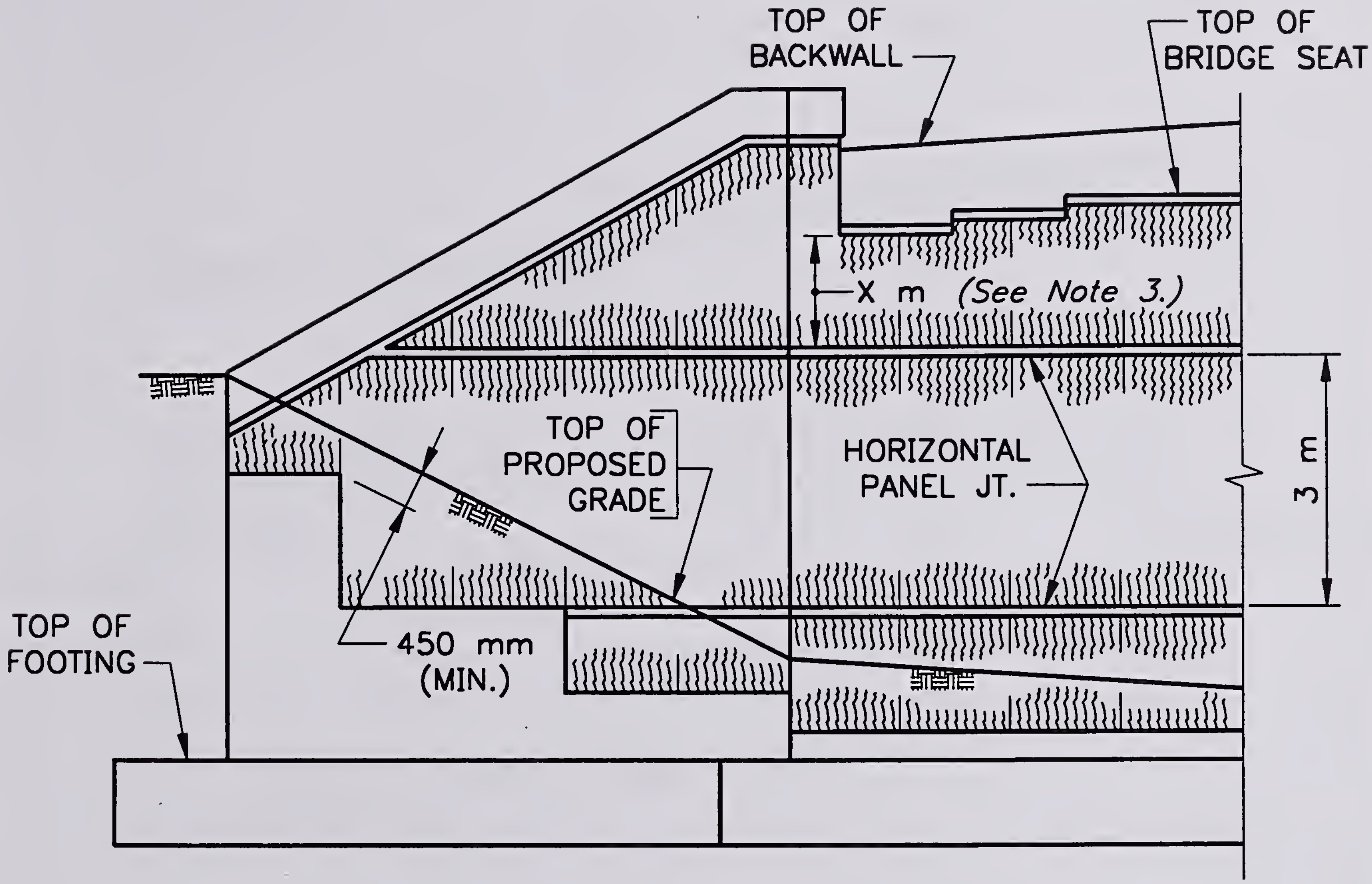
NOT TO SCALE

NOTES:

1. *A detailed elevation view of the abutment and wingwalls shall be drawn to scale, without breaks, and shall include the above information and depiction of the striations. In addition it shall include all other relevant dimensions and elevations. See elevation view of splayed wingwalls for abutment details.*
2. *The size of a typical striation form liner panel is 1.2 m W x 3 m H. These dimensions should be used as a guide in laying out the location of the construction, expansion, and horizontal panel joints.*
3. *Set horizontal panel joint a minimum of 1.2 m below the lowest point of the bridge seat. All other horizontal panel joints shall be dimensioned from this one. All joint lines shall be continuous across wingwalls and abutment.*

Plot Scale = 1:100

MASS HIGHWAY BRIDGE MANUAL	U–WINGWALLS STRIATION DETAILS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **3.4.1**



NOTE: HORIZONTAL PANEL JOINTS SHALL BE LEVEL.

ELEVATION

NOT TO SCALE

NOTES:

1. *A detailed elevation view of the abutment and wingwalls shall be drawn to scale, without breaks, and shall include the above information and depiction of the striations. In addition it shall include all other relevant dimensions and elevations.*
2. *The size of a typical striation form liner panel is 1.2 m W x 3 m H. These dimensions should be used as a guide in laying out the location of the construction, expansion, and horizontal panel joints.*
3. *Set horizontal panel joint a minimum of 1.2 m below the lowest point of the bridge seat. All other horizontal panel joints shall be dimensioned from this one. All joint lines shall be continuous across wingwalls and abutment.*

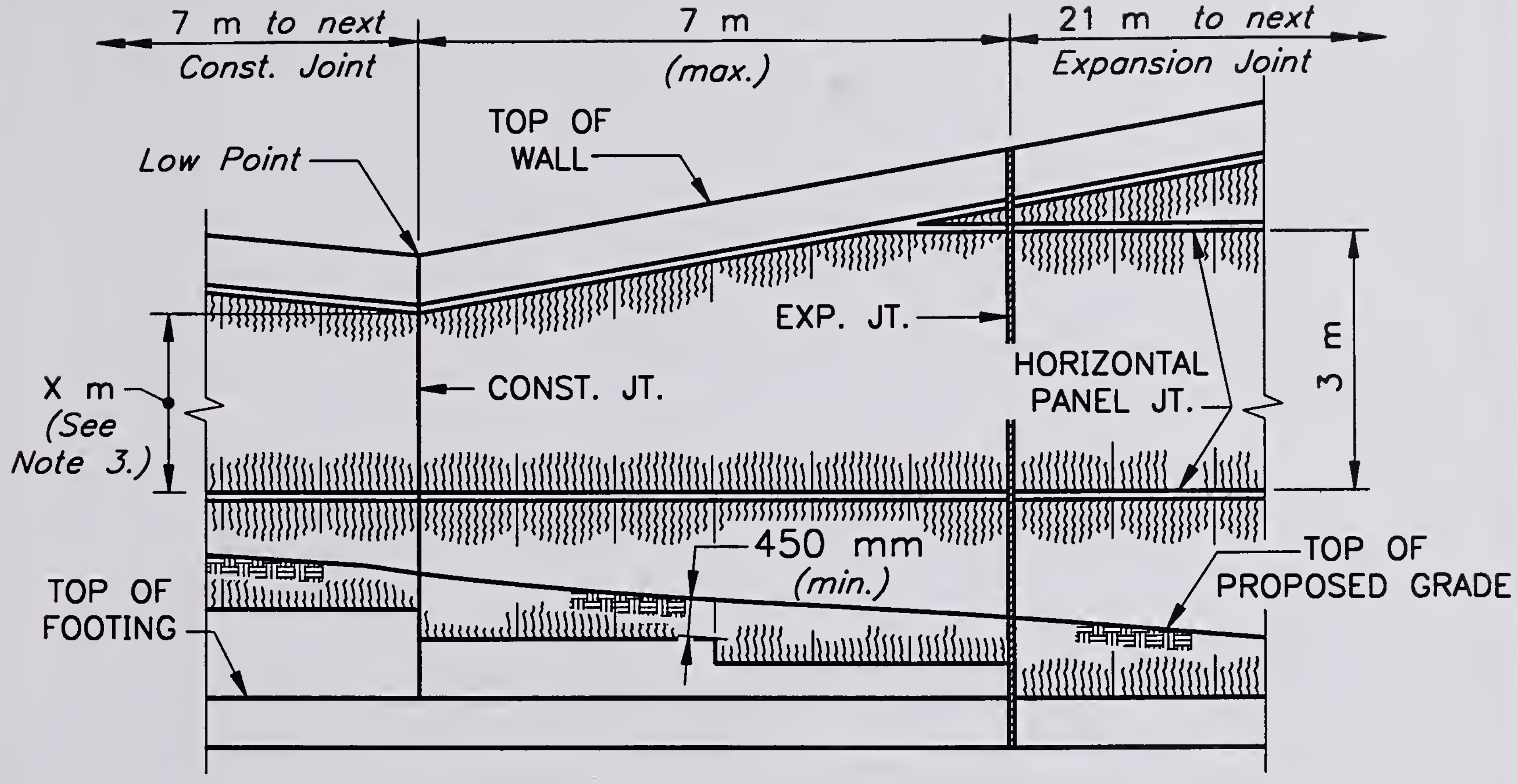
Plot Scale = 1:100

MASSHIGHWAY
BRIDGE
MANUAL

SPLAYED WINGWALLS
STRIATION DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.4.2



NOTE: HORIZONTAL PANEL JOINTS SHALL BE LEVEL.

ELEVATION

NOT TO SCALE

NOTES:

1. *A detailed elevation view of a retaining wall shall be drawn to scale and shall include the above information and depiction of the striations. In addition, it shall include all other relevant dimensions and elevations.*
2. *The size of a typical striation form liner panel is 1.2 m W x 3 m H. These dimensions should be used as a guide in laying out the location of the construction, expansion, and horizontal panel joints.*
3. *When a horizontal panel joint will not intercept the top of wall coping, set this horizontal joint a minimum of 1.2 m below the lowest point on the wall. Any smaller dimension may cause the sloping coping lines to clash visually with the level horizontal joint.*
4. *If a long retaining wall abuts or extends from a bridge abutment or wingwall, the horizontal joints should be continuous through all striated wall surfaces.*

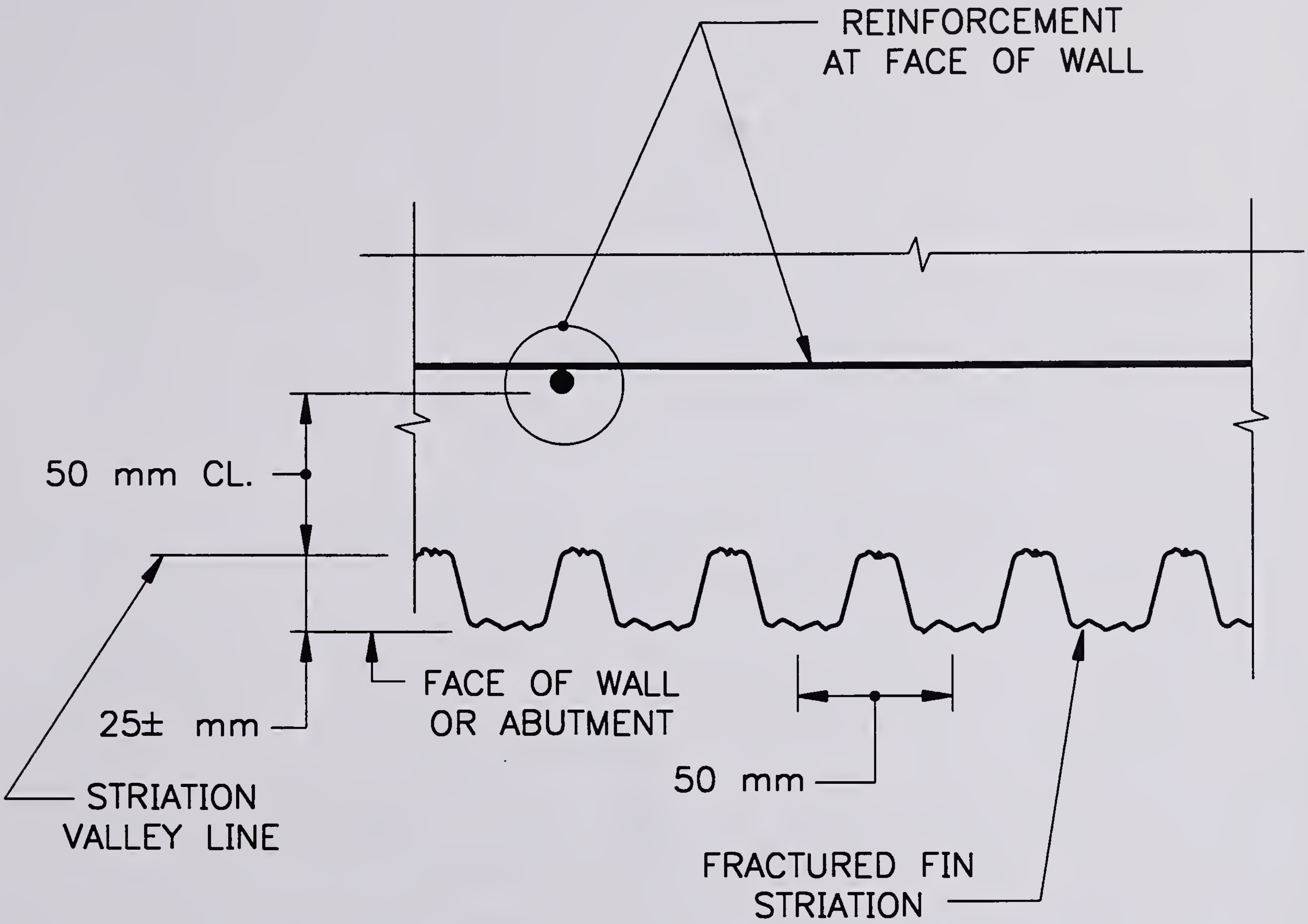
Plot Scale = 1:100

MASS HIGHWAY
BRIDGE
MANUAL

LONG RETAINING WALLS
STRIATION DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.4.3



NOTES:

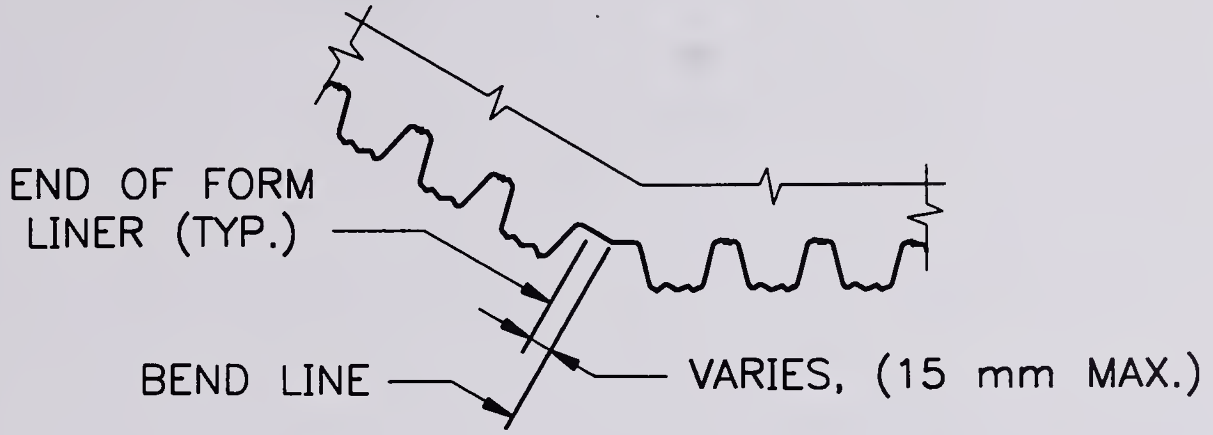
1. THE CONTRACTOR SHALL MAKE SURE THAT THE STRIATION FINS ARE PLUMB AND THAT THE FINS LINE UP VERTICALLY FROM PANEL TO PANEL FOR THE FULL HEIGHT OF THE WALL.
2. THE HORIZONTAL JOINT MAY BE OMITTED IF THE CONTRACTOR CAN DEMONSTRATE THAT THE FORM LINER PANELS CAN BE INSTALLED END TO END WITHOUT CREATING A VISIBLE SEAM IN THE FINAL CAST CONCRETE.

TYPICAL STRIATION DETAIL

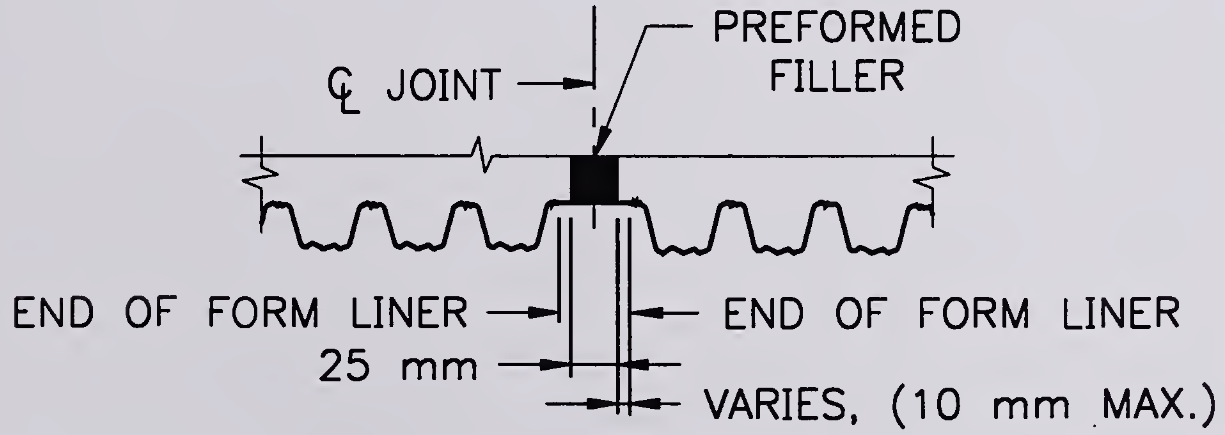
NOT TO SCALE

Plot Scale = 1:2.5

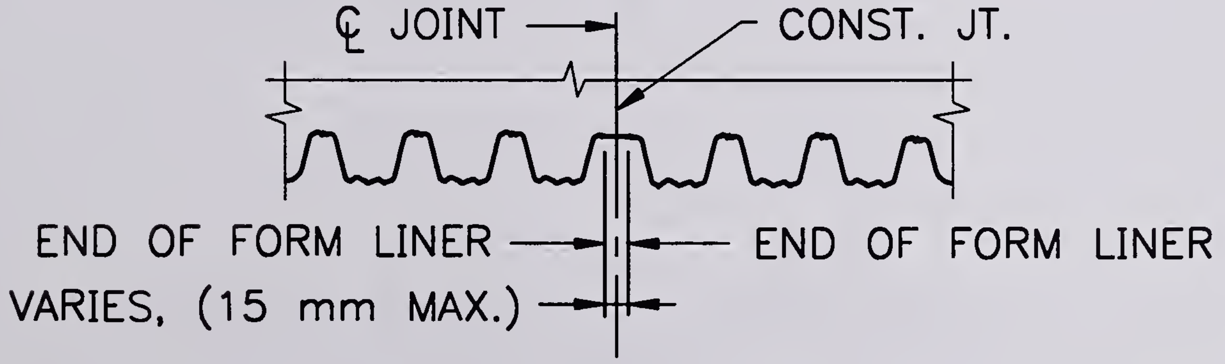
MASSHIGHWAY BRIDGE MANUAL	TYPICAL STRIATION DETAIL STRIATION DETAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.4.4**



DETAIL AT WALL CORNER
NOT TO SCALE



EXPANSION JOINT
NOT TO SCALE



CONSTRUCTION JOINT
NOT TO SCALE

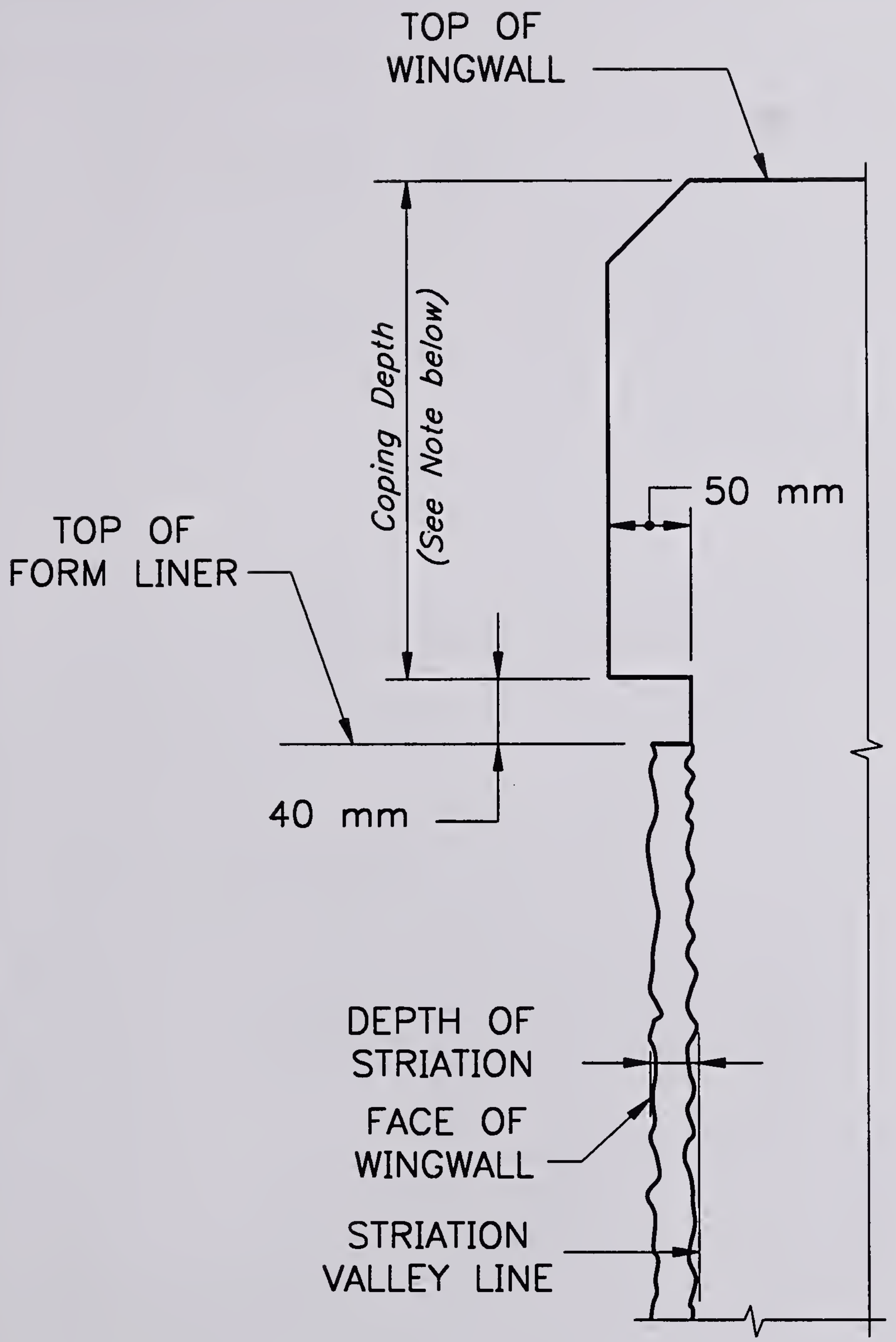
Plot Scale = 1:5

MASS HIGHWAY
BRIDGE
MANUAL

DETAILS
AT CORNERS AND JOINTS
STRIATION DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.4.5



DETAIL AT TOP OF WINGWALL

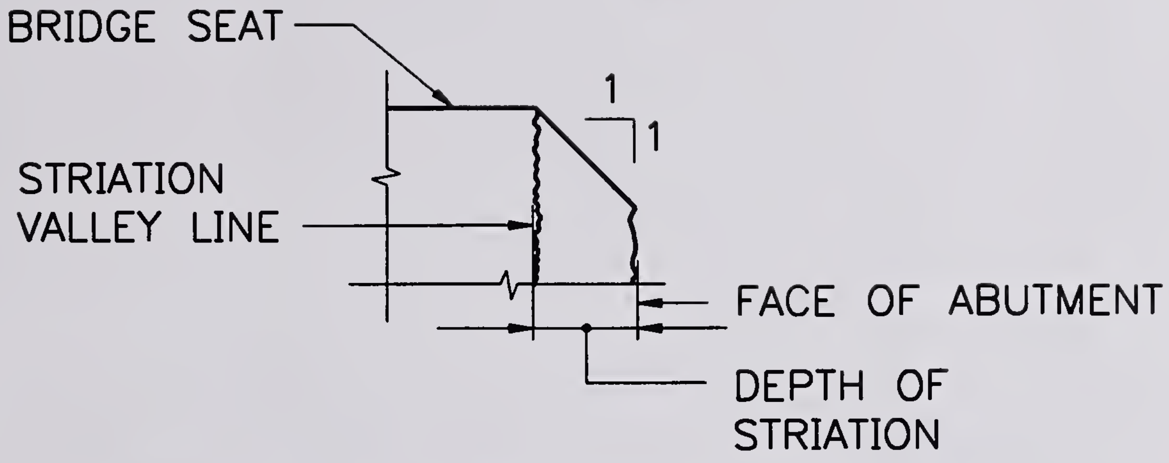
NOT TO SCALE

NOTE:

For Splayed Wingwalls, coping depth is 300 mm with 50 mm chamfer at the top. For U–Wingwalls, match the detail shown in the Top of Wingwall Details (Chapter 9, Railing/Traffic Barrier Systems) for the type of bridge rail used.

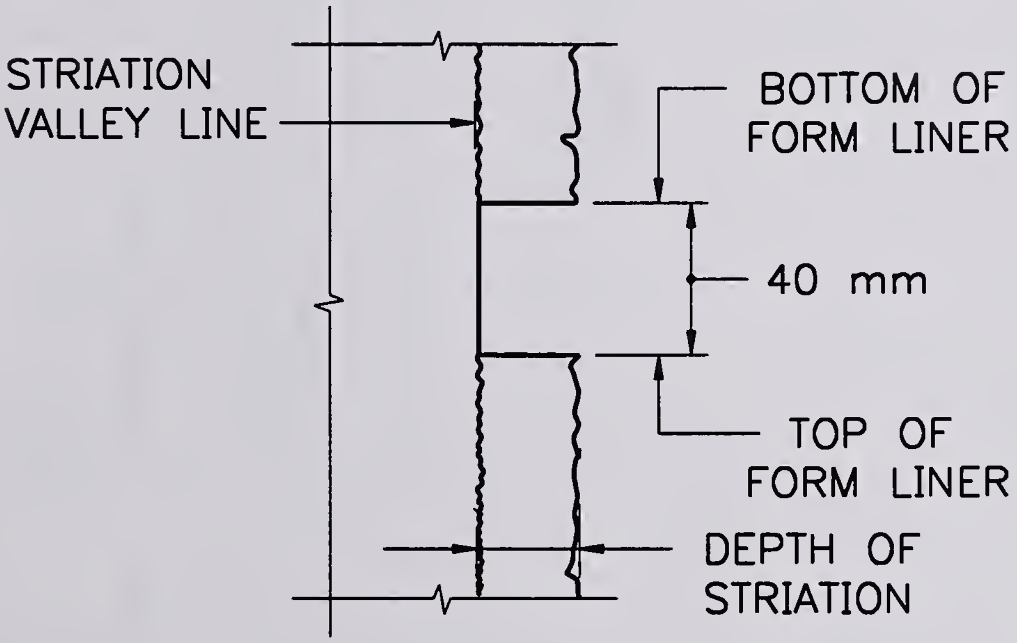
Plot Scale = 1:5

MASS HIGHWAY BRIDGE MANUAL	DETAIL AT TOP OF WINGWALL STRIATION DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.4.6**



DETAIL AT BRIDGE SEAT

NOT TO SCALE



HORIZONTAL PANEL JOINT

NOT TO SCALE

Plot Scale = 1:2.5

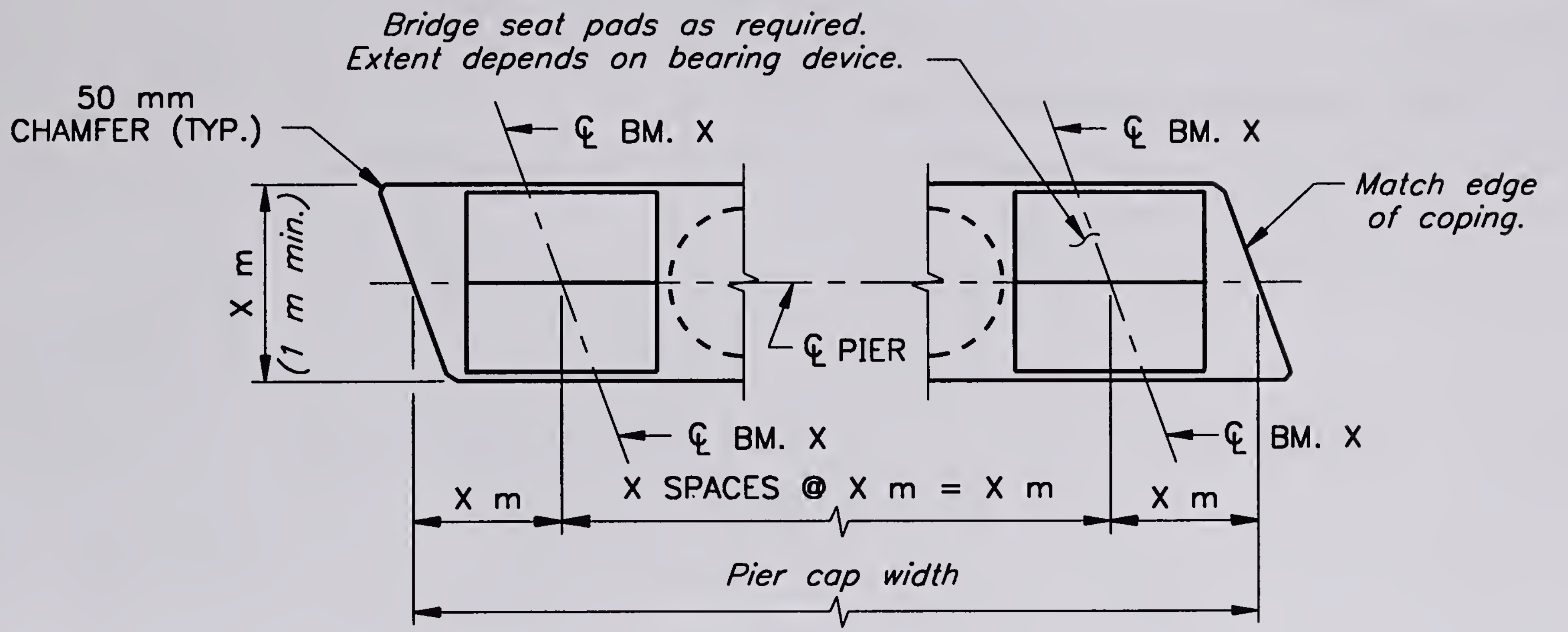
MASS HIGHWAY
BRIDGE
MANUAL

MISCELLANEOUS DETAILS
STRIATION DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.4.7

Plot Scale = 1:50



PLAN OF PIER

SCALE (1:50 min.)

NOTES:

1. *Above drawing is not to scale. Pier cap for separated beam bridges shown. See Chapter 4, Section 5, for details for butted beam bridges.*
2. *Remainder of pier has been omitted for clarity. Plan view of pier shall be drawn without breaks and to scale on the construction plans. Include footing and all relevant dimensions, angles, survey information and north arrow.*
3. *Bridge seat pads may vary in height from 15 mm to 300 mm. For pads 100 mm or more, add reinforcement to pad. If more than 300 mm height is required, use bolsters as detailed in Chapter 8, Bearing Devices.*

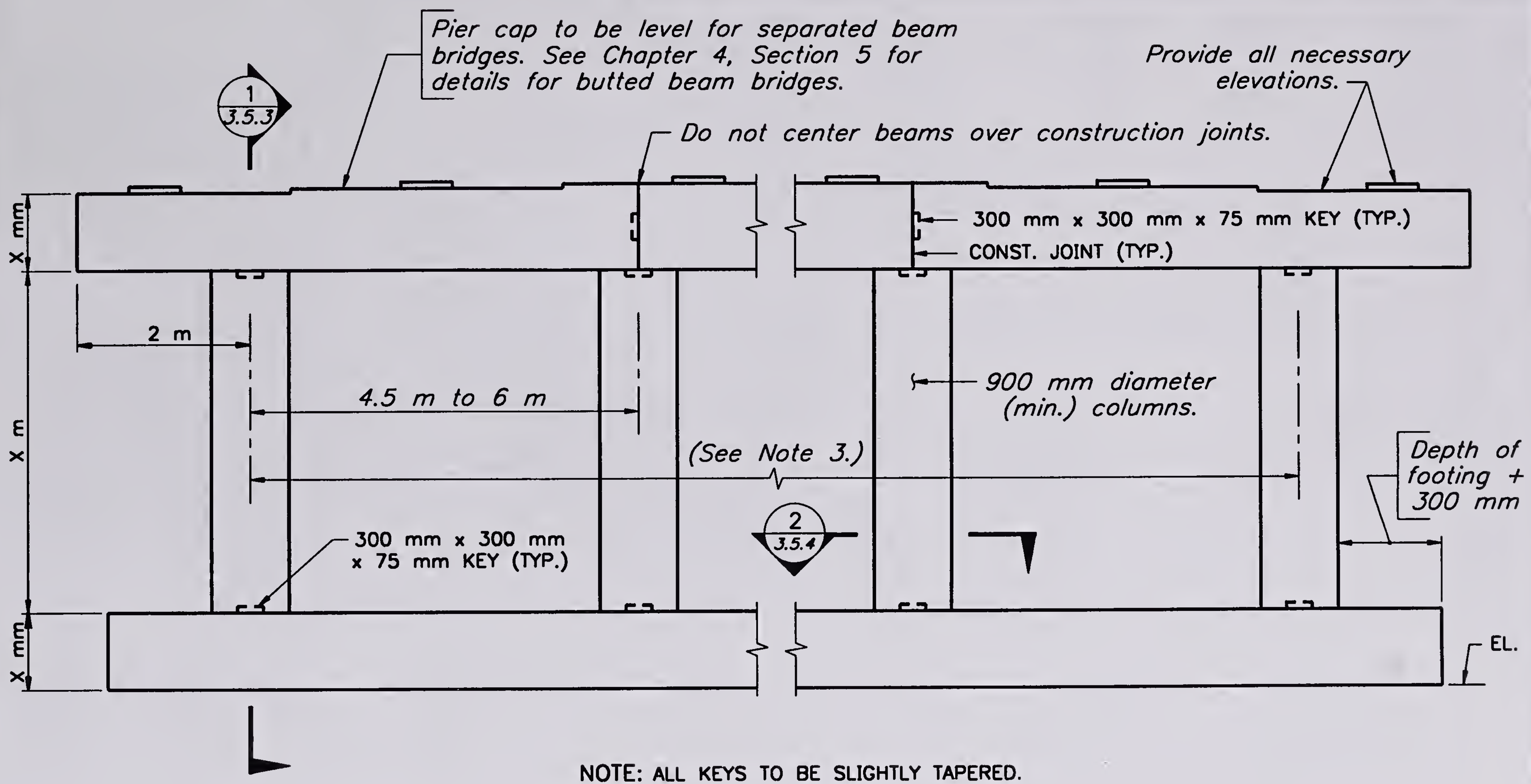
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL PLAN VIEW
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.5.1

Plot Scale = 1:75


Pier cap to be level for separated beam bridges. See Chapter 4, Section 5 for details for butted beam bridges.
Provide all necessary elevations.
Do not center beams over construction joints.
1
3.5.3
300 mm x 300 mm x 75 mm KEY (TYP.)
CONST. JOINT (TYP.)
x mm
x m
x mm
2 m
4.5 m to 6 m
900 mm diameter (min.) columns.
(See Note 3.)
Depth of footing + 300 mm
2
3.5.4
300 mm x 300 mm x 75 mm KEY (TYP.)
EL.

NOTE: ALL KEYS TO BE SLIGHTLY TAPERED.

TRANSVERSE SECTION OF PIER

SCALE (1:50 min.)

NOTES:

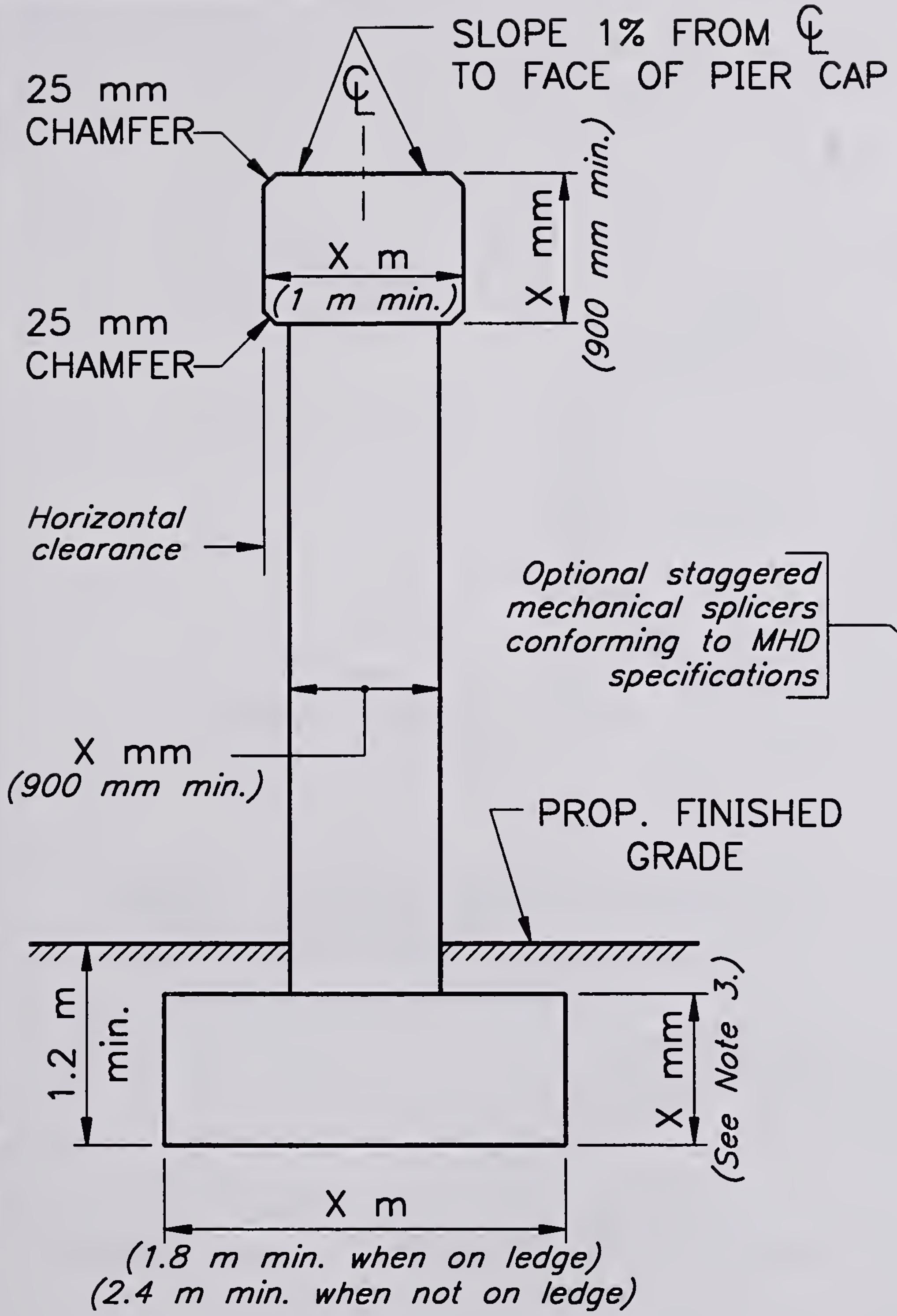
1. *Above drawing is not to scale.*
2. *The transverse section shall be drawn without breaks and to scale on construction plans and all pier cap and footing reinforcement shall be included. locate this section under the plan view of the pier.*
3. *If the dimensions from center line to center line of exterior columns exceeds 24 m, provide two separate pier caps on a continuous footing.*
4. *Provide crash wall or solid pier where required by railroad or hydraulics.*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL TRANSVERSE SECTION
PIER DETAILS

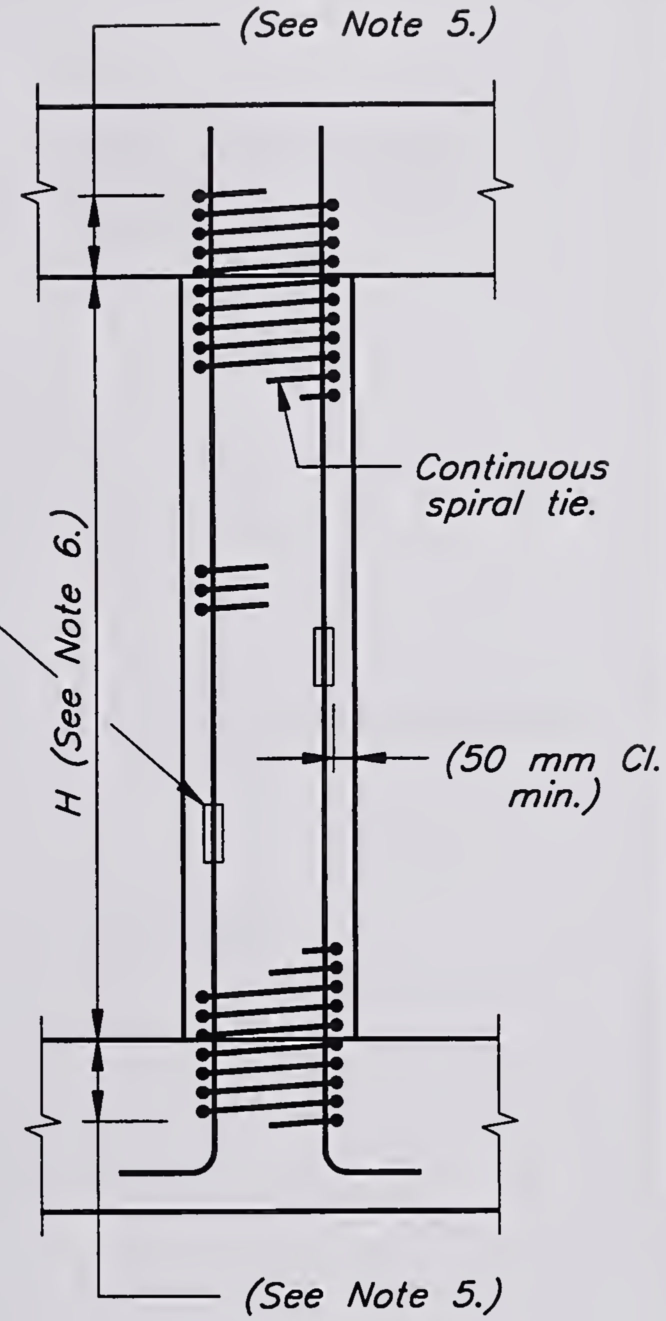
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.5.2



SECTION 1

SCALE (1:X)



TYPICAL REINFORCEMENT

NOTES:

1. Above drawing is not to scale.
2. The vertical column section shall be included on the construction plans with all reinforcement labeled. Provide proper embedment lengths.
3. Maximum depth of footing shall be 900 mm for footings on subsoil, 1.0 m for footings on piles, and 750 mm for footings on ledge.
4. Use continuous footings where footing is on subsoil or piles. Use individual footings where footing is on ledge. Deep foundation may be required where soils are prone to liquefaction.
5. Extend spirals into footing and pier cap as required by AASHTO Seismic Design Specifications.
6. For column height, H, less than 10 m no lap splice allowed. For H of 10 m or more splices are allowed in center half of column and shall conform to AASHTO Seismic Design Specifications.

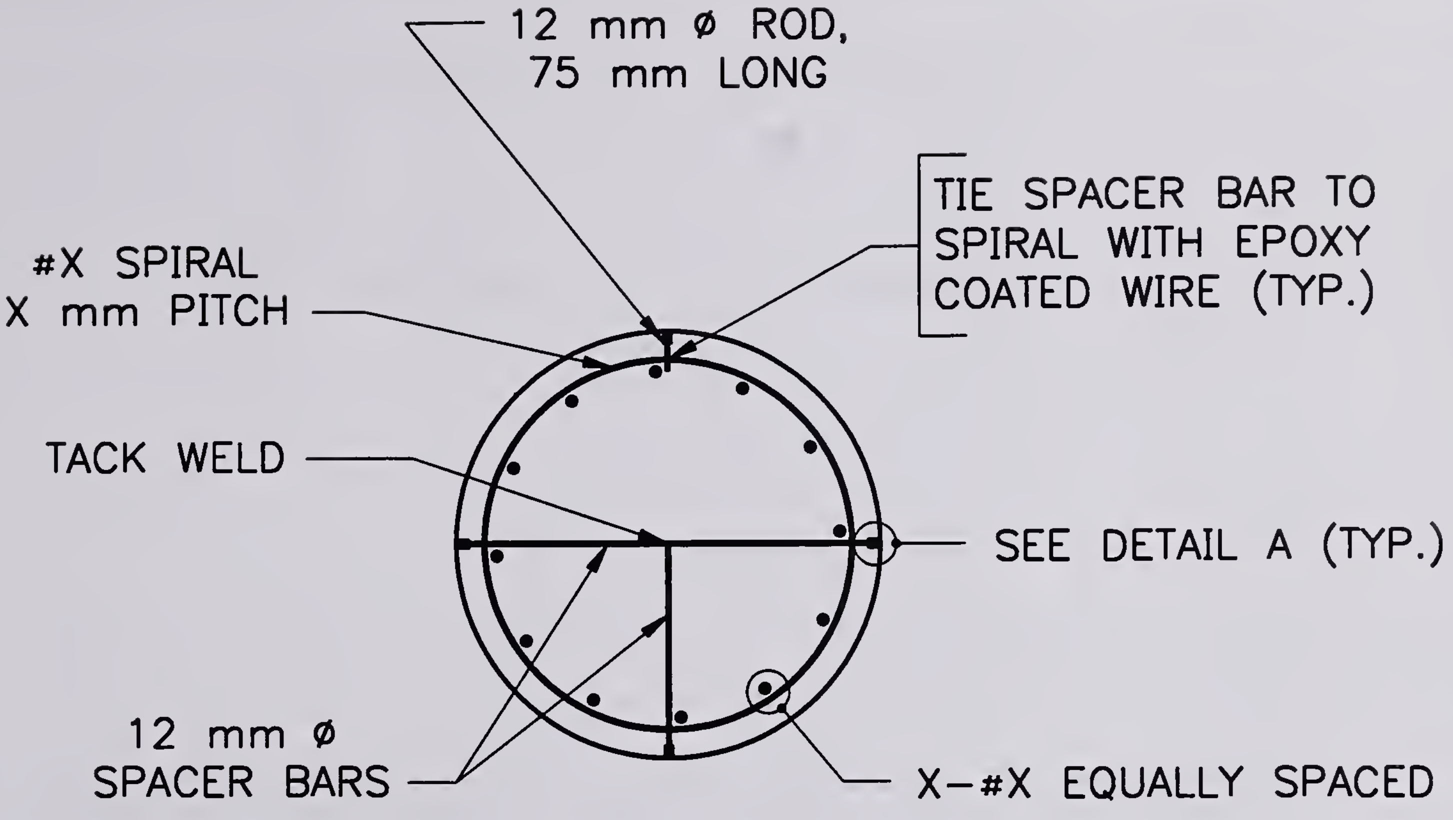
Plot Scale = 1:50

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL VERTICAL COLUMN
SECTION
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

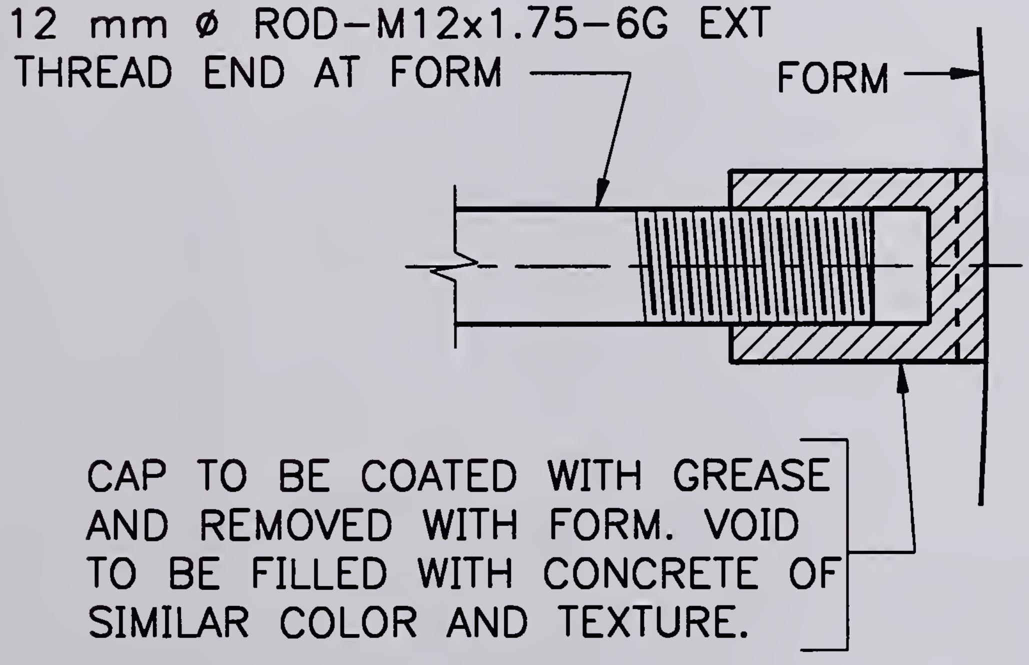
DRAWING NUMBER
3.5.3



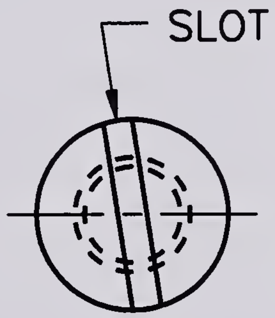
NOTE: SPACER BARS TO BE PLACED AT 1/4 POINTS IN COLUMN.

SECTION 2

SCALE (1:20 min.)



CAP TO BE COATED WITH GREASE AND REMOVED WITH FORM. VOID TO BE FILLED WITH CONCRETE OF SIMILAR COLOR AND TEXTURE.



END OF CAP

DETAIL A

NOT TO SCALE

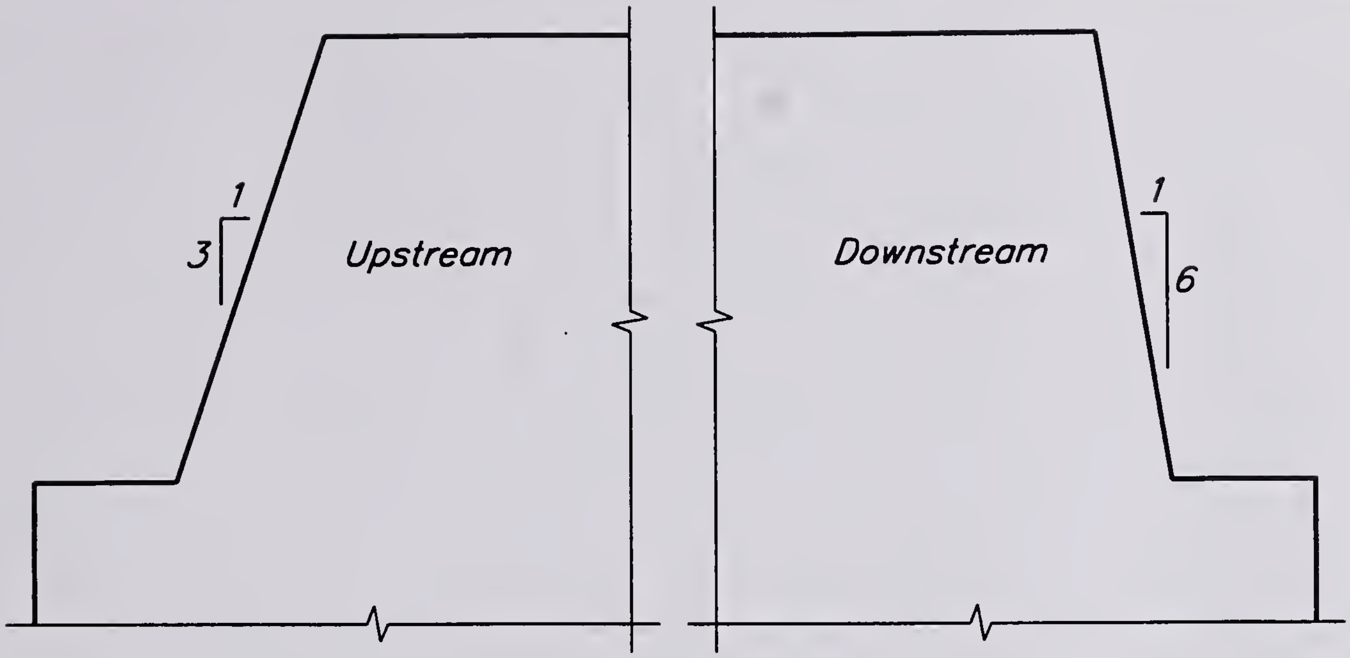
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL HORIZONTAL COLUMN SECTION
PIER DETAILS

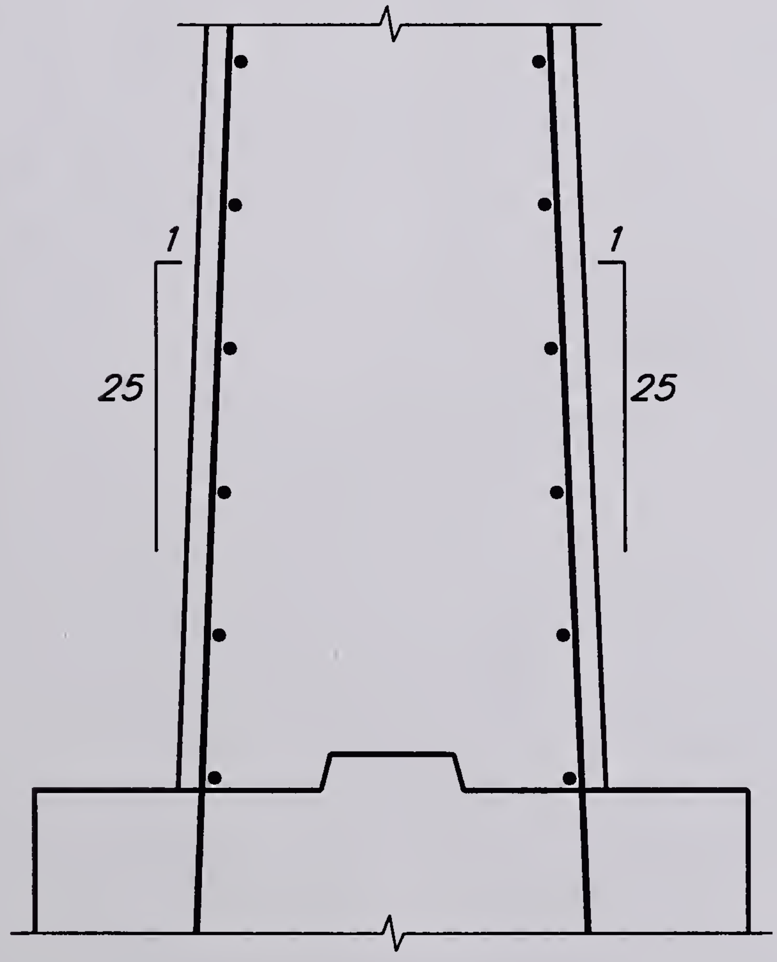
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.5.4

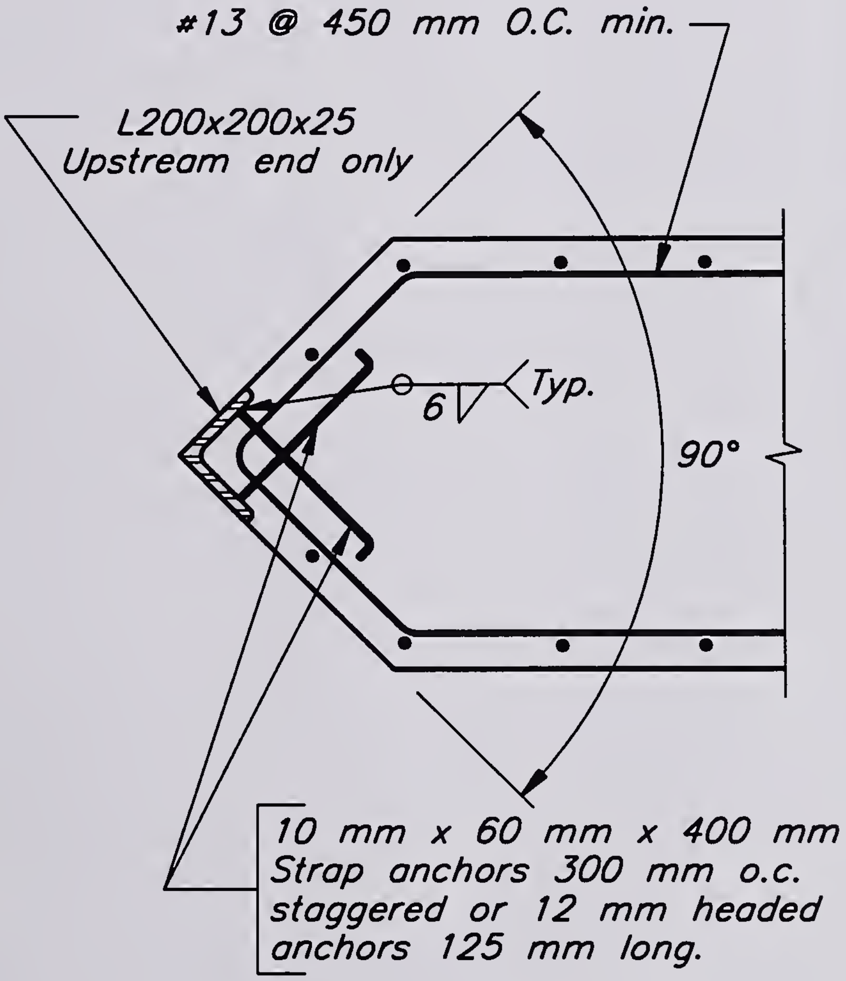


NOTE: Upstream noses to have 200 mm x 200 mm x 25 mm galvanized steel angle from footing to 600 mm above design flood water.

ELEVATION
(Not to scale)



SECTION
(Not to scale)



#13 @ 450 mm O.C. min.

L200x200x25
Upstream end only

10 mm x 60 mm x 400 mm Strap anchors 300 mm o.c. staggered or 12 mm headed anchors 125 mm long.

DETAIL OF NOSE
(Not to scale)

MASS HIGHWAY
BRIDGE
MANUAL

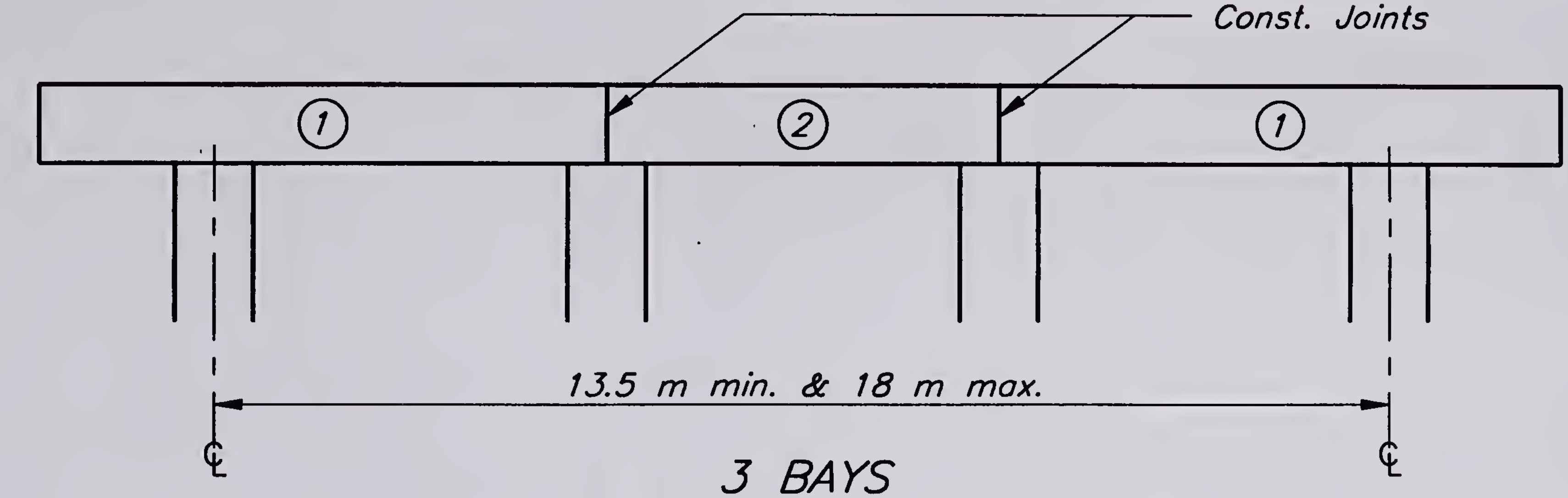
MODIFICATIONS FOR RIVER PIERS
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

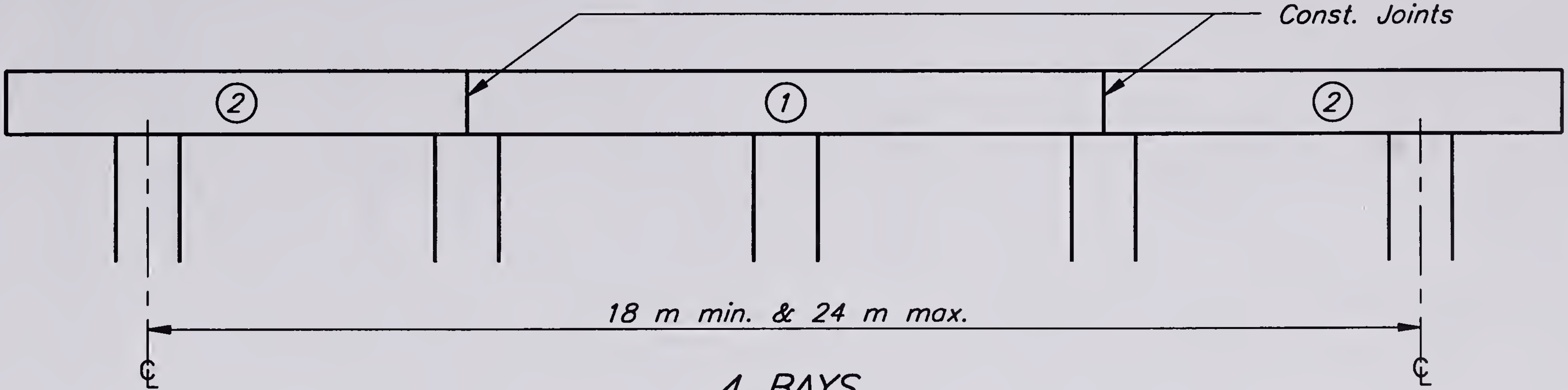
DRAWING NUMBER
3.5.5

Plot Scale = 1:20

Plot Scale = 1:100



3 BAYS



4 BAYS

NOTES:

1. Pour segments ① first. Pour segments ② not less than 24 hours after the completion of pour segments ①. Forms to be stripped as prescribed in the specifications. Note the pouring sequence and 24 hour minimum set time on the construction plans.
2. For 5 or more bays over 24 m, see Dwg. No. 3.5.2.

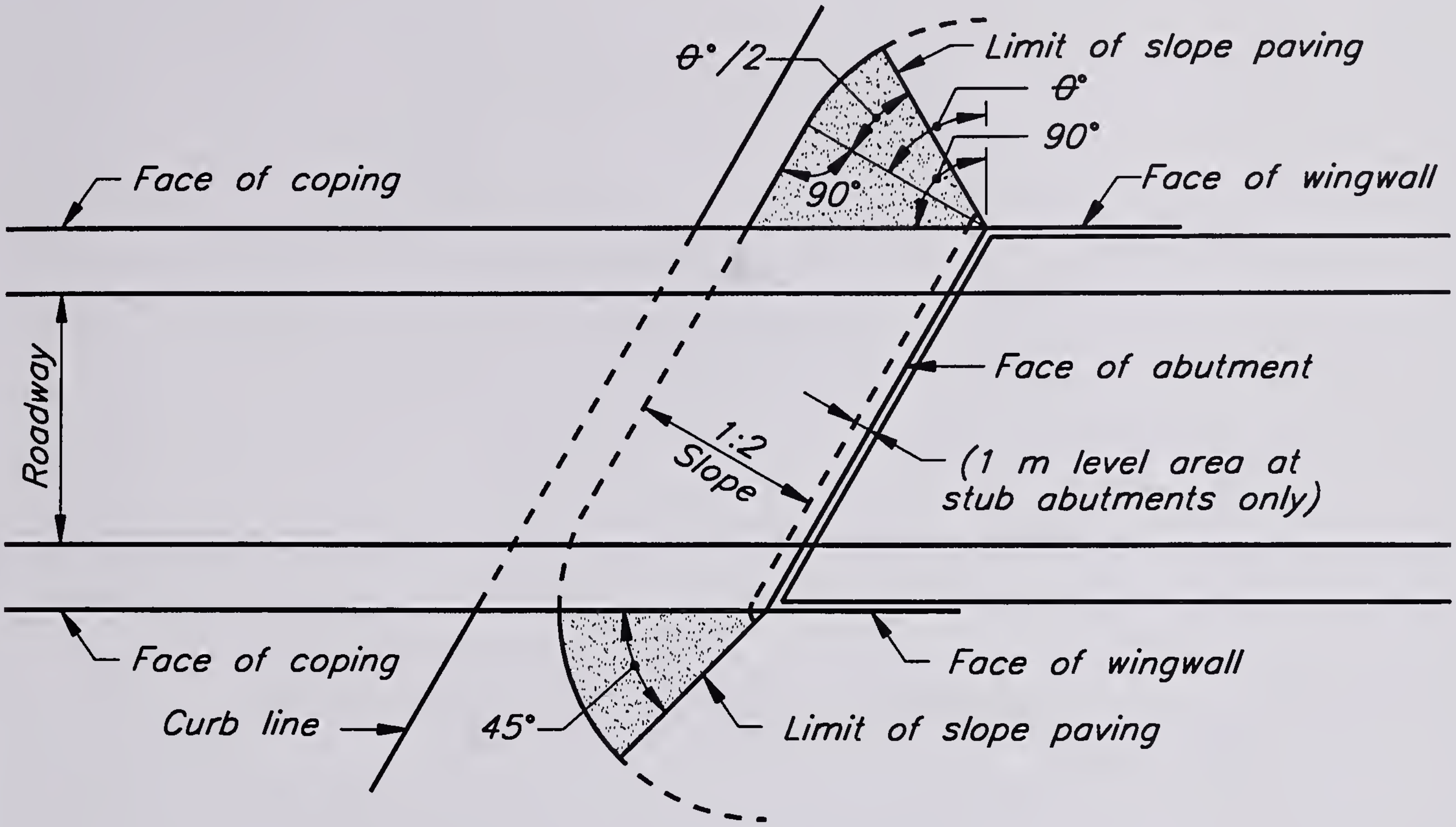
MASS HIGHWAY
BRIDGE
MANUAL

POURING SEQUENCE OF PIER CAPS

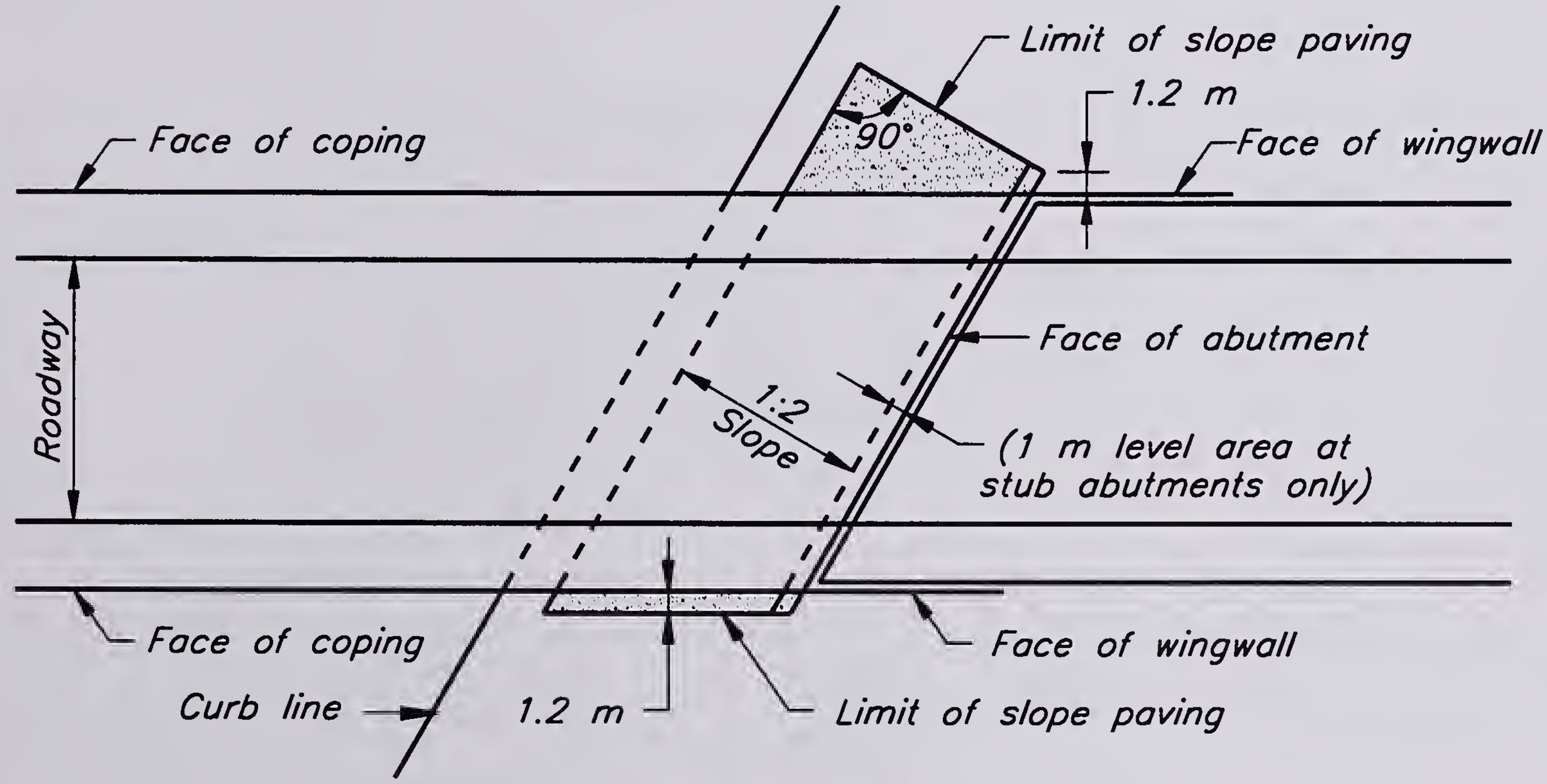
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.5.6



FILL SECTION

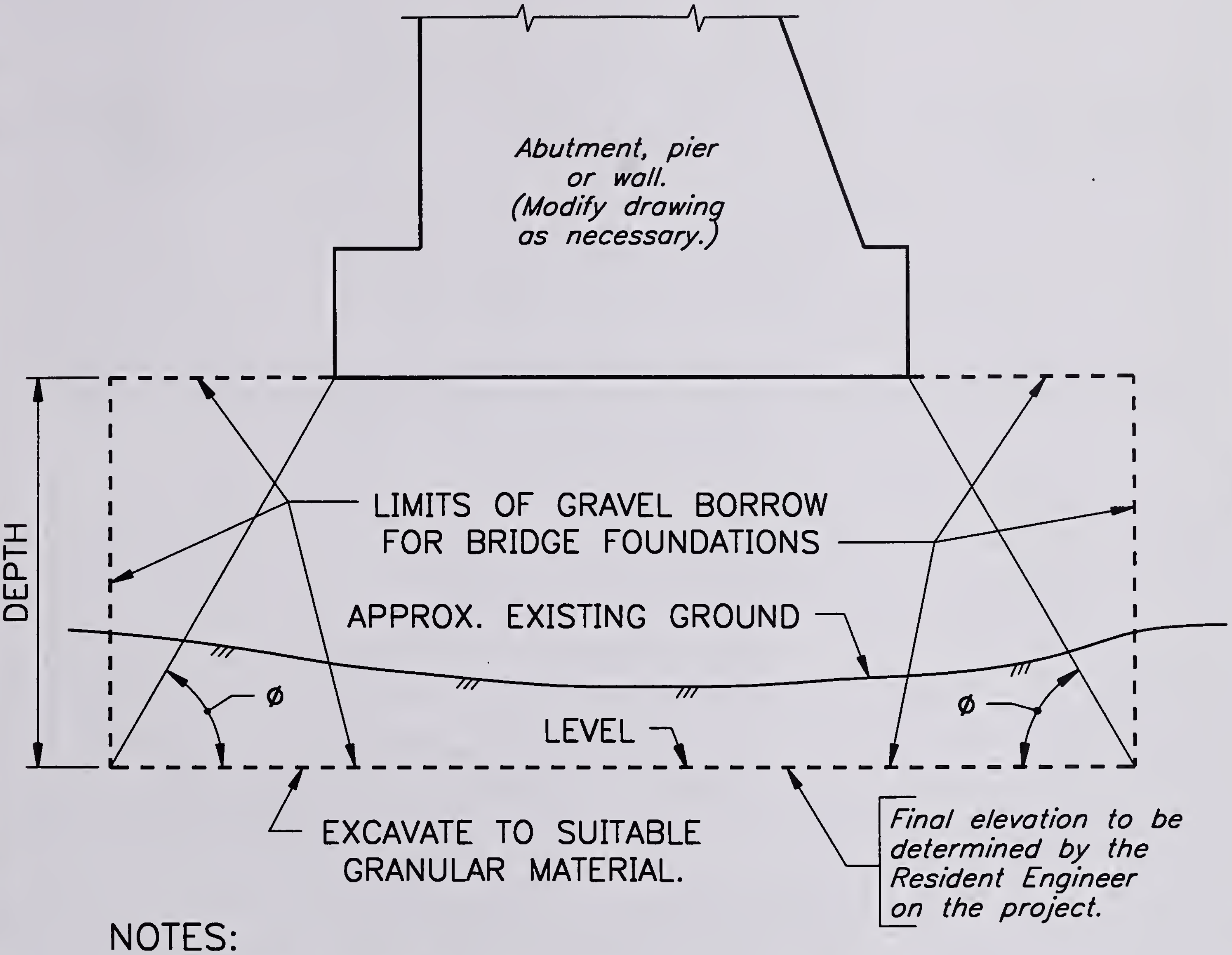


CUT SECTION

NOTE: *Include the limits of special slope paving on the construction plans where applicable.*

Plot Scale = 1:500

MASS HIGHWAY BRIDGE MANUAL	LIMITS OF SPECIAL SLOPE PAVING FOUNDATIONS AND FILL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.6.1**


Abutment, pier or wall. (Modify drawing as necessary.)
DEPTH
LIMITS OF GRAVEL BORROW FOR BRIDGE FOUNDATIONS
APPROX. EXISTING GROUND
ø
ø
LEVEL
EXCAVATE TO SUITABLE GRANULAR MATERIAL.
Final elevation to be determined by the Resident Engineer on the project.

NOTES:

1. ø = 45° FOR DEPTH OF 1.5 m OR LESS.
   ø = 60° FOR DEPTH OVER 1.5 m.
2. SAME TREATMENT IS TO BE USED AT ENDS OF WALLS, PIERS, AND ABUTMENTS.

LIMITS OF GRAVEL BORROW FOR BRIDGE FOUNDATIONS

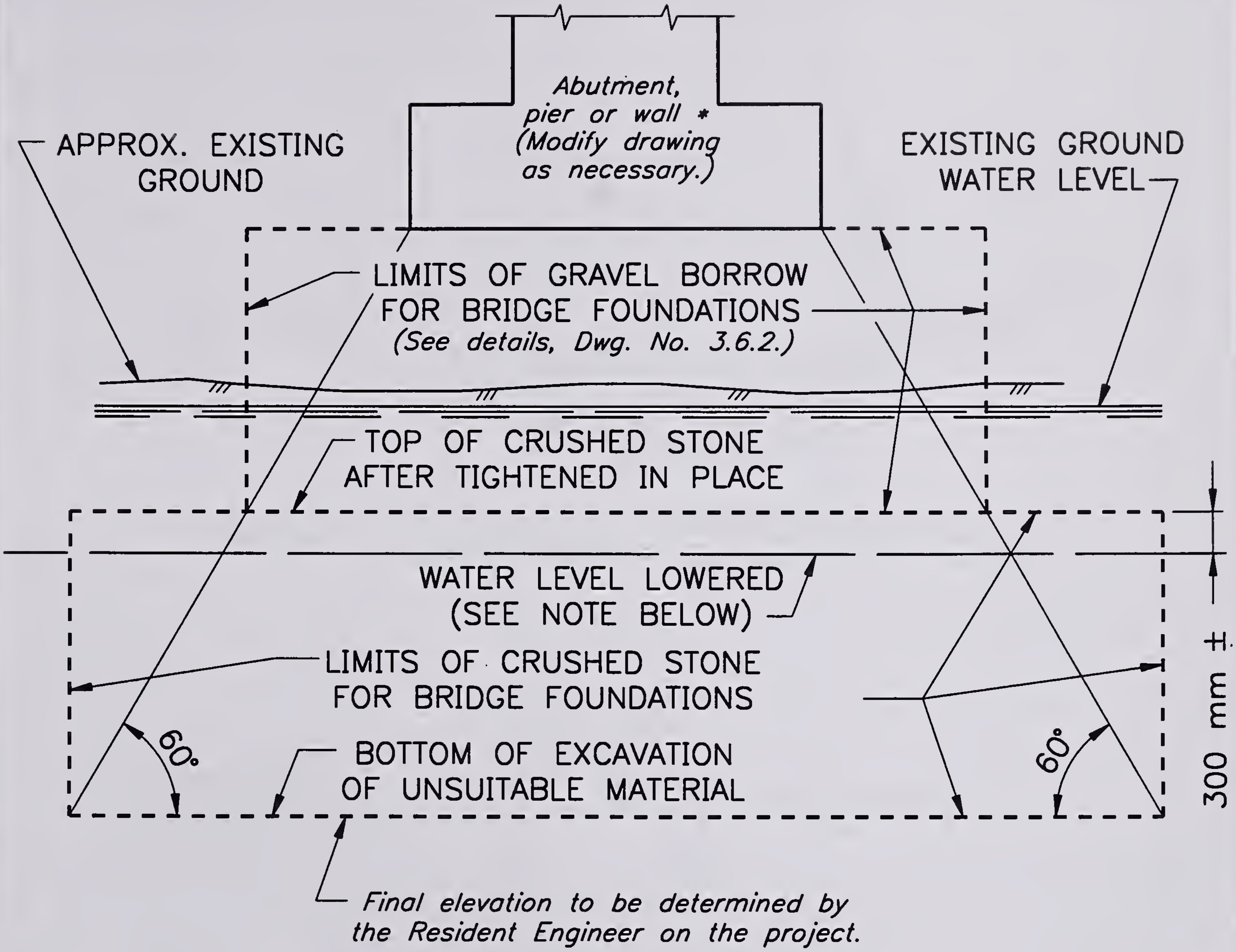
NOT TO SCALE

NOTES:

1. *Do not use where bridge is over waterway or retaining wall is along waterway.*
2. *Maximum allowable bearing pressure under footing is 200 kPa (normal conditions). Up to 300 kPa may be used when approved by the Bridge Engineer.*
3. *Gravel borrow must be installed in the dry. Use water control where required.*

Plot Scale = 1:50

MASS HIGHWAY BRIDGE MANUAL	GRAVEL BORROW FOR BRIDGE FOUNDATIONS FOUNDATIONS AND FILL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.6.2**


Abutment, pier or wall * (Modify drawing as necessary.)
APPROX. EXISTING GROUND
EXISTING GROUND WATER LEVEL
LIMITS OF GRAVEL BORROW FOR BRIDGE FOUNDATIONS (See details, Dwg. No. 3.6.2.)
TOP OF CRUSHED STONE AFTER TIGHTENED IN PLACE
WATER LEVEL LOWERED (SEE NOTE BELOW)
LIMITS OF CRUSHED STONE FOR BRIDGE FOUNDATIONS
60°
60°
BOTTOM OF EXCAVATION OF UNSUITABLE MATERIAL
300 mm ±
Final elevation to be determined by the Resident Engineer on the project.

NOTE: LOWER WATER LEVEL AS MUCH AS POSSIBLE WITHOUT DISTURBING THE GRANULAR SOIL (SIDES AND BOTTOM) AND TIGHTEN THE CRUSHED STONE IN PLACE (SEE STANDARD SPECIFICATIONS).

LIMITS OF CRUSHED STONE FOR BRIDGE FOUNDATIONS

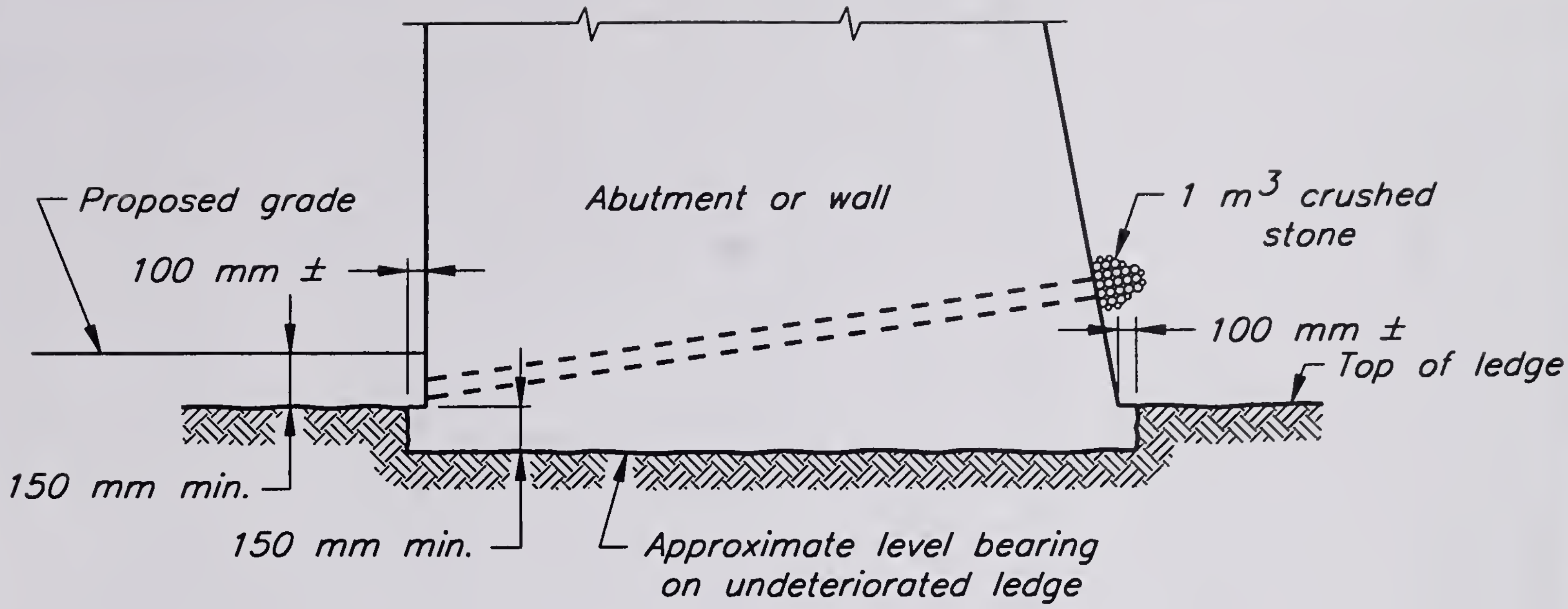
NOT TO SCALE

NOTES:

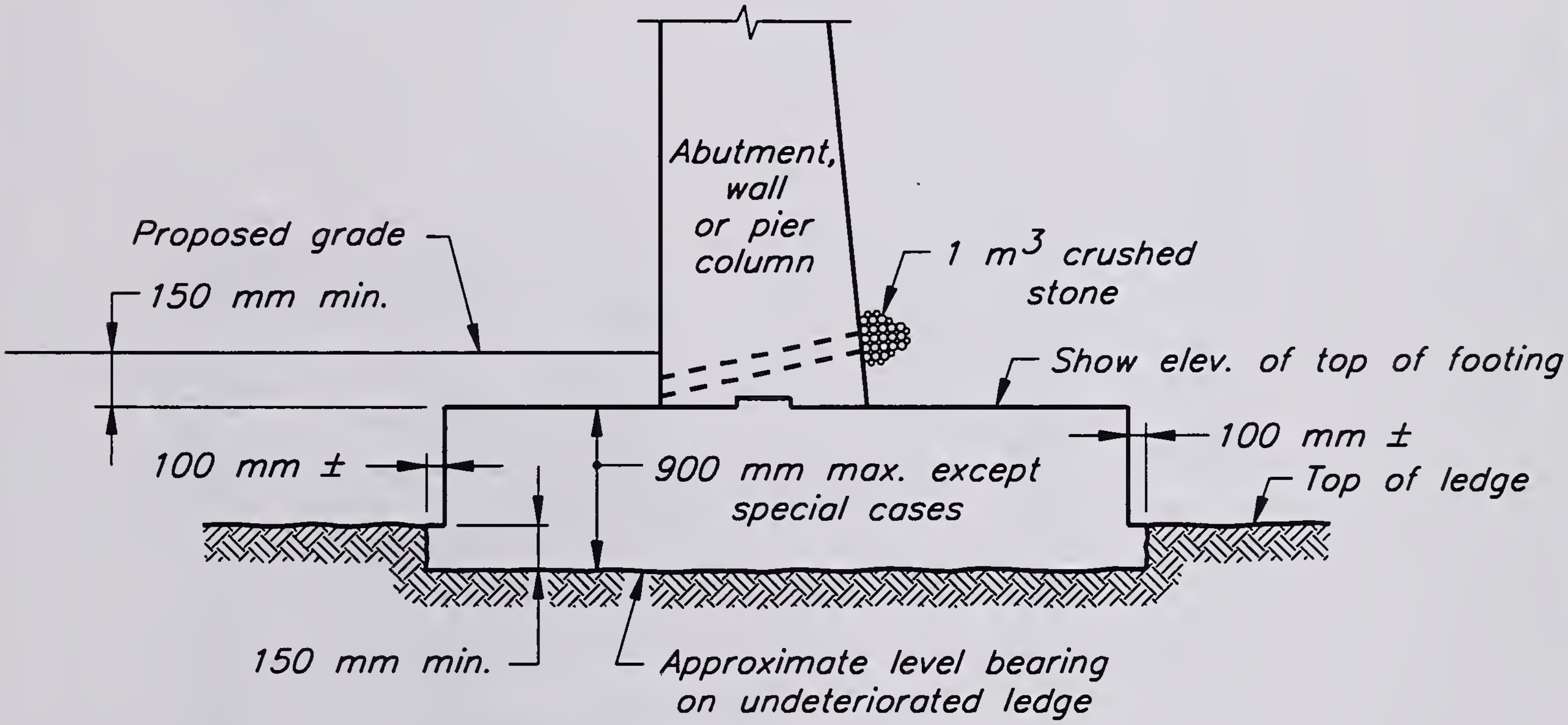
1. * *Do not use for water crossing.*
2. *Indicate maximum soil pressure under crushed stone.*

Plot Scale = 1:50

MASS HIGHWAY BRIDGE MANUAL	CRUSHED STONE FOR BRIDGE FOUNDATIONS FOUNDATIONS AND FILL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.6.3**



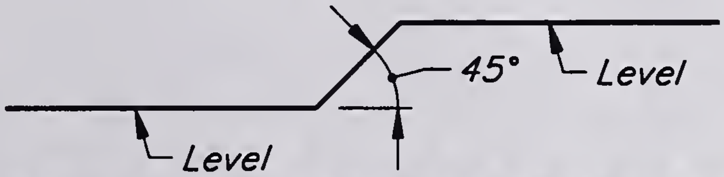
GRAVITY ABUTMENT OR GRAVITY WALL


Abutment, wall or pier column
Proposed grade
150 mm min.
1 m^3 crushed stone
Show elev. of top of footing
100 mm ±
100 mm ±
Top of ledge
900 mm max. except special cases
150 mm min.
Approximate level bearing on undeteriorated ledge

CANTILEVER ABUTMENT OR CANTILEVER WALL

NOTES:

1. Length of wall shall be stepped to conform with ledge:



2. For cantilever walls on ledge, the footing shall be designed so that the resultant of the pressure occurs within the middle half of the footing.

Plot Scale = 1:50

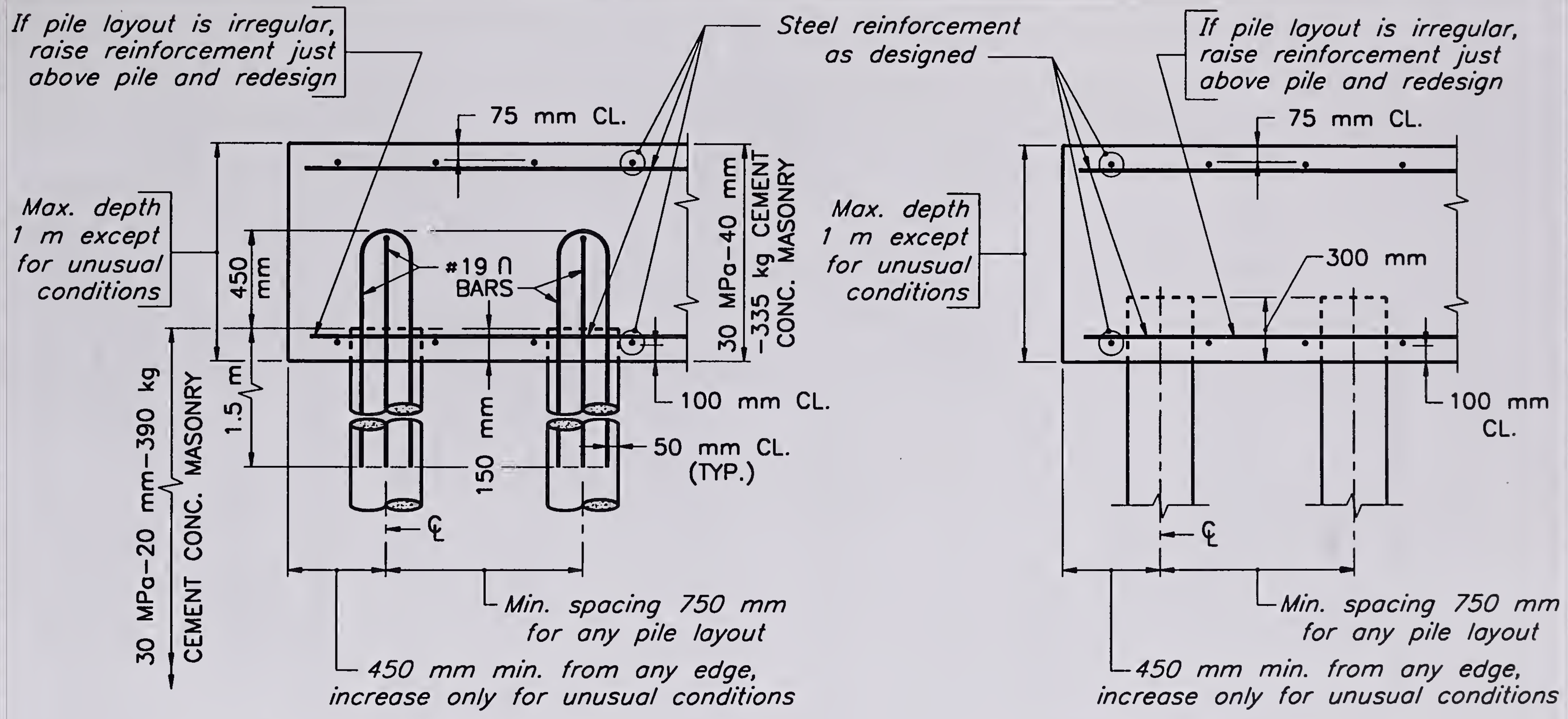
MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR FOOTINGS
ON LEDGE
FOUNDATIONS AND FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.4

Plot Scale = 1:30



If pile layout is irregular, raise reinforcement just above pile and redesign
Steel reinforcement as designed
If pile layout is irregular, raise reinforcement just above pile and redesign
75 mm CL.
75 mm CL.
Max. depth 1 m except for unusual conditions
450 mm
#19 ∩ BARS
30 MPa–40 mm –335 kg CEMENT CONC. MASONRY
Max. depth 1 m except for unusual conditions
300 mm
1.5 m
100 mm CL.
100 mm CL.
30 MPa–20 mm–390 kg CEMENT CONC. MASONRY
150 mm
50 mm CL. (TYP.)
℄
℄
Min. spacing 750 mm for any pile layout
Min. spacing 750 mm for any pile layout
450 mm min. from any edge, increase only for unusual conditions
450 mm min. from any edge, increase only for unusual conditions

FOOTING WITH CAST-IN-PLACE CONCRETE PILES AND PIPE PILES FILLED WITH CONCRETE

FOOTING WITH TIMBER OR STEEL PILES

NOTES:

1. DESIGN PILE LOAD = XX kN.
2. PILES TO BE DRIVEN TO PRACTICAL REFUSAL. *(Steel piles only)*
   PILES TO BE DRIVEN TO A MIN. BEARING CAPACITY OF XX kN. *(All other piles)*

PILE LAYOUT

SCALE (1:20 min.)

NOTES:

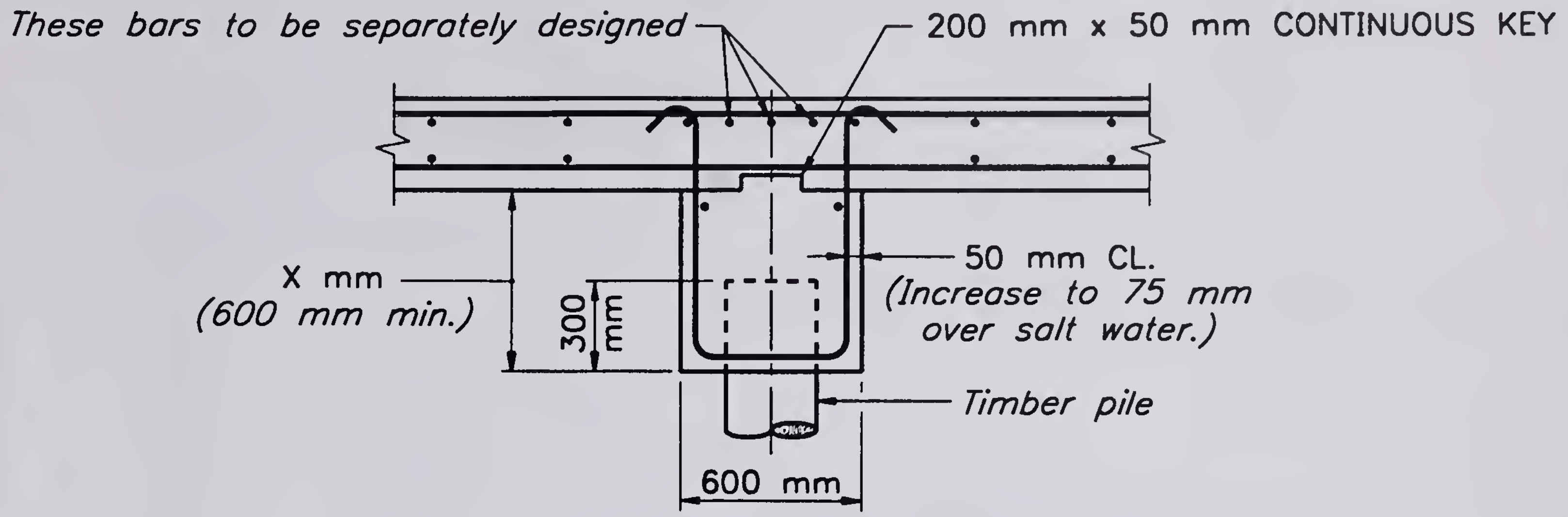
1. *Above drawing is not to scale.*
2. *Show and note total number of piles in plan view of pile layout for each substructure.*
3. *Note the estimated pile tip elevations on the construction plans.*
4. *Maximum longitudinal spacing of piles = 3 m.*
5. *Provide at least 450 mm of concrete above the top of each pile.*

MASSHIGHWAY
BRIDGE
MANUAL

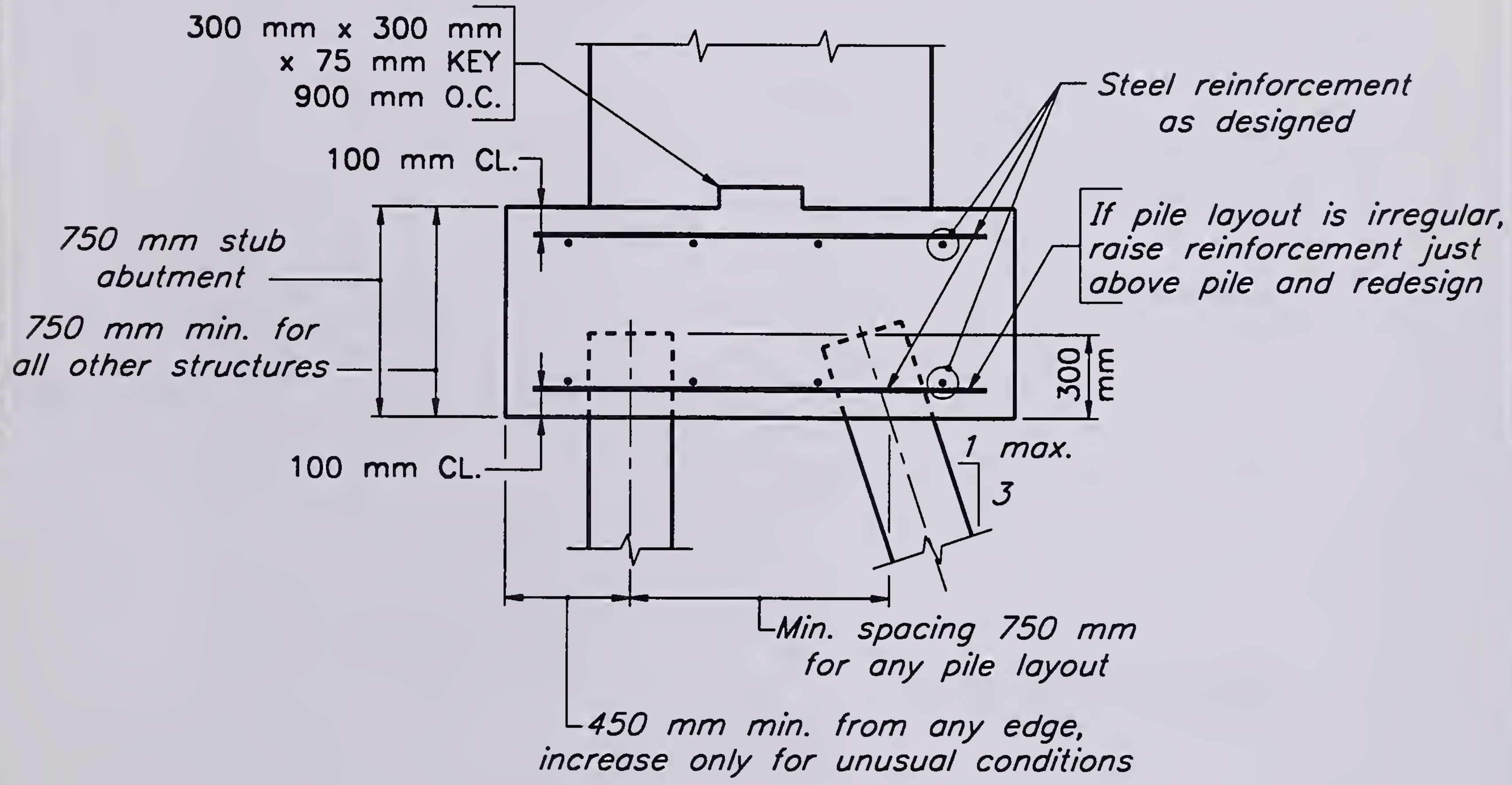
PILE DETAILS
LONGITUDINAL LAYOUT
FOUNDATION AND FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.5


These bars to be separately designed
200 mm x 50 mm CONTINUOUS KEY
X mm
(600 mm min.)
300 mm
50 mm CL.
(Increase to 75 mm over salt water.)
Timber pile
600 mm

PILE CAP FOR TRESTLE BRIDGE


300 mm x 300 mm
x 75 mm KEY
900 mm O.C.
100 mm CL.
750 mm stub abutment
750 mm min. for all other structures
100 mm CL.
Steel reinforcement as designed
If pile layout is irregular, raise reinforcement just above pile and redesign
300 mm
1 max.
3
Min. spacing 750 mm for any pile layout
450 mm min. from any edge, increase only for unusual conditions

FOOTING WITH BATTERED PILES

PILE LAYOUT

SCALE (1:20 min.)

NOTES:

1. Above drawing is not to scale.
2. Embedment of steel piles may exceed 300 mm if required.
3. Provide at least 450 mm of concrete above the top of each pile.
4. Embedment of steel or timber piles shown.
5. Maximum transverse spacing of piles = 3 m.

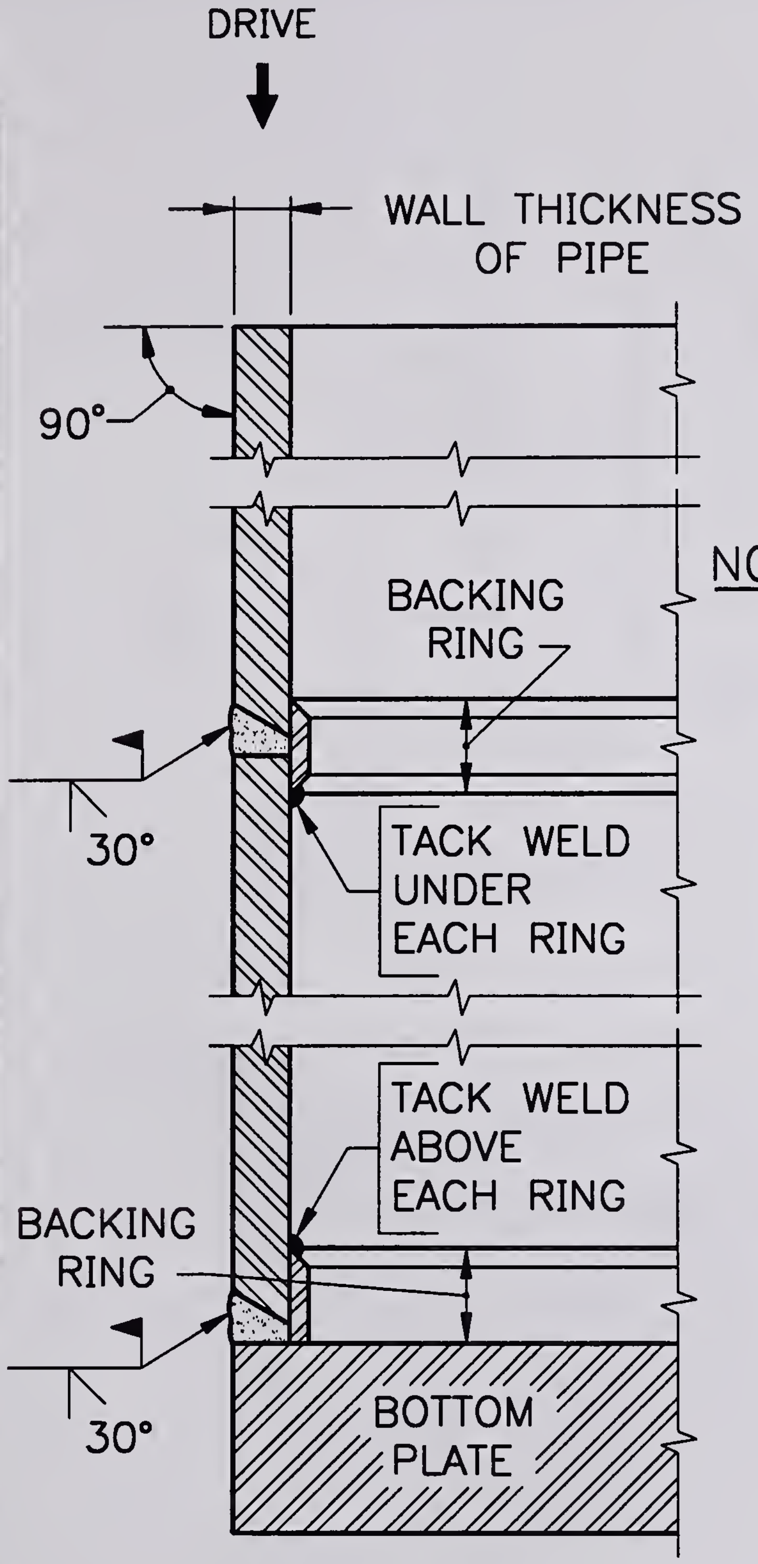
Plot Scale = 1:30

MASSHIGHWAY
BRIDGE
MANUAL

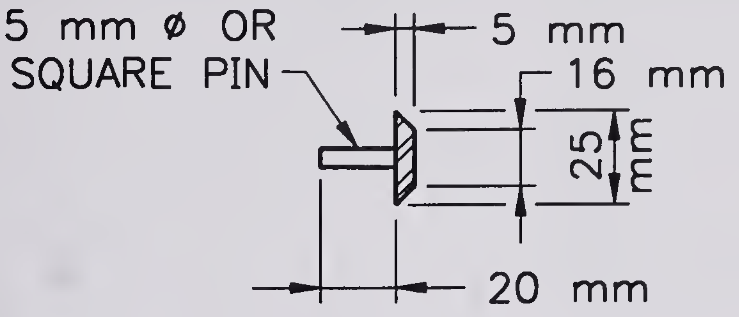
PILE DETAILS
TRANSVERSE LAYOUT
FOUNDATION AND FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.6



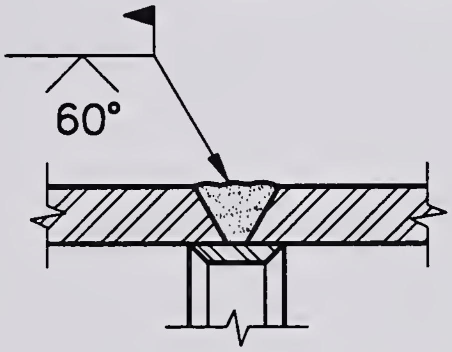
PILE SECTION



SECTION THRU BACKING RING

NOTES:

1. EACH BACKING RING SHALL HAVE 5 PINS EQUALLY SPACED.
2. ROOT BASE SHALL BE DEPOSITED TO WITHIN 25 mm OF BACKING RING SPACER PINS. SPACER PINS SHALL THEN BE REMOVED AND PASS COMPLETED.
3. ALL WELDS SHALL BE SMOOTH. REINFORCEMENT SHALL NOT EXCEED 3 mm.
4. WELDING SHALL CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.
5. FOR FLAT WELD POSITION USE THE FOLLOWING WELD:



PILE SPLICE AND BOTTOM PLATE DETAILS

NOT TO SCALE

NOTE: For piles subjected to moment, note on plans that all welds shall be nondestructively tested using radiography or ultrasonics.

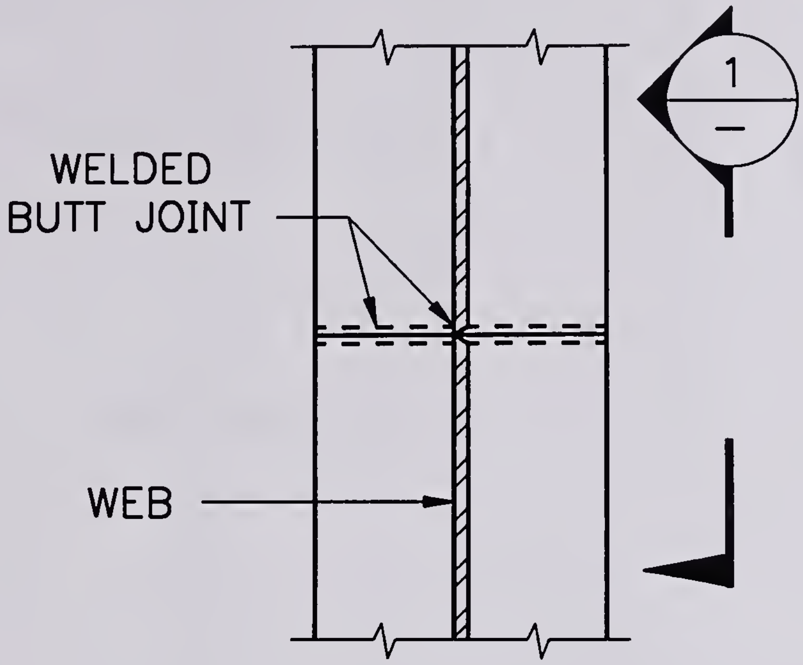
Plot Scale = 1:2.5

MASSHIGHWAY
BRIDGE
MANUAL

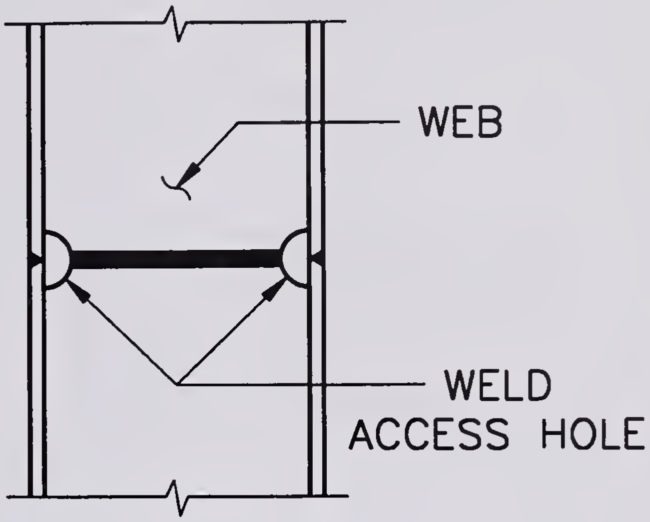
PIPE PILE DETAILS
FOUNDATIONS AND FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.7



SECTIONAL VIEW



SECTION 1

NOTES:

1. ALL WELDS SHALL BE COMPLETE PENETRATION AND SHALL CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.
2. WELDING PROCEDURES MUST BE APPROVED BY THE ENGINEER PRIOR TO WELDING.
3. WHENEVER POSSIBLE ALL PILES SHALL BE SPLICED ON THE GROUND IN THE FLAT POSITION.
4. WEB SHALL BE COPED TO ALLOW FOR COMPLETE PENETRATION WELDING OF FLANGES.

H-PILE SPLICE DETAILS

SCALE (1:10 min.)

NOTES:

1. *For piles subject to moment, note on construction plans that welds shall be nondestructively tested using radiography or ultrasonics.*
2. *Pile splice details shall be shown on construction plans of all bridges requiring steel piles.*
3. *Pile splices to be a separate item in the Bridge Estimate.*

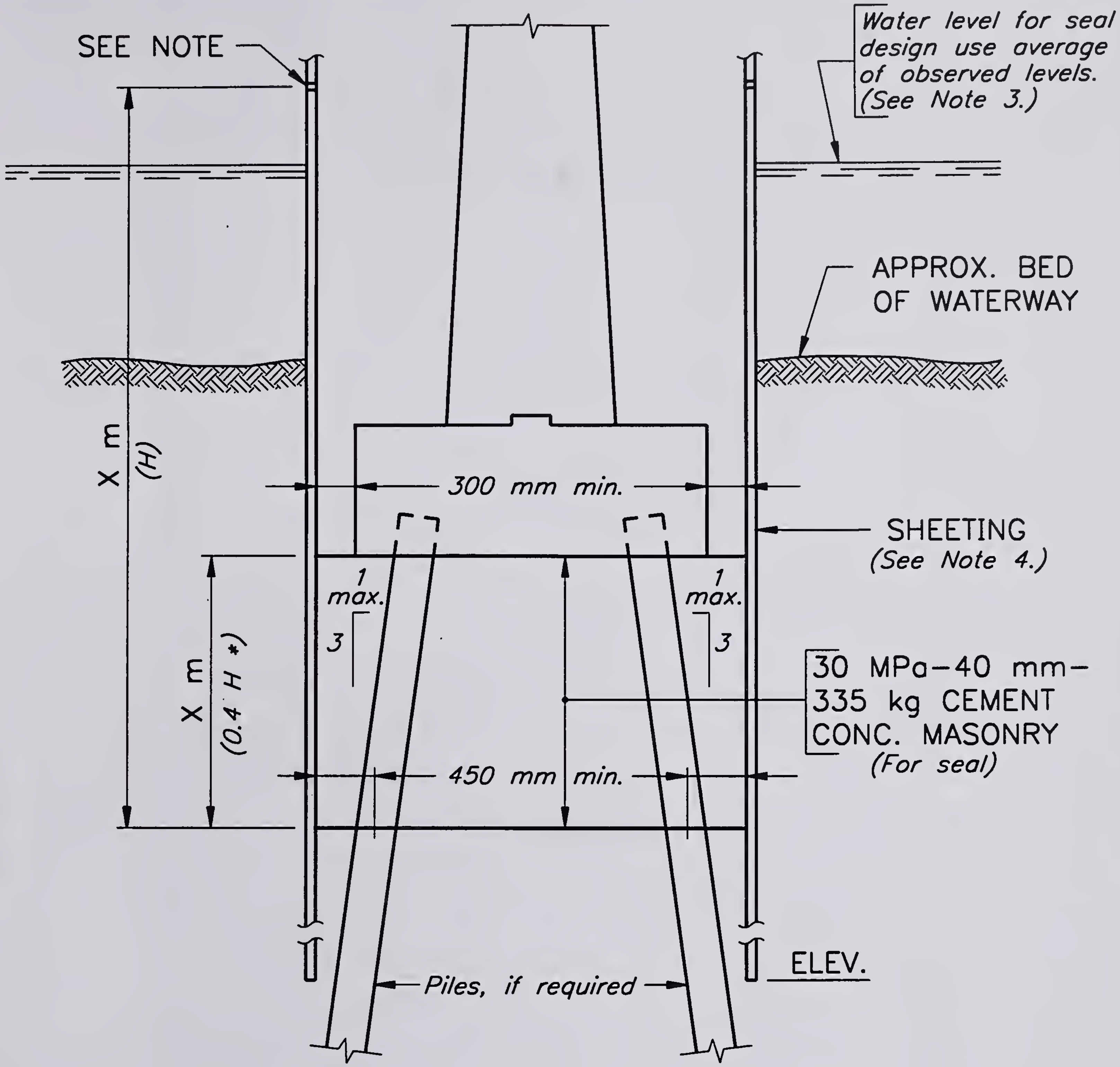
Plot Scale = 1:10

MASS HIGHWAY
BRIDGE
MANUAL

H-PILE DETAILS
FOUNDATIONS AND FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.8



NOTE: CONTRACTOR SHALL PROVIDE PRESSURE RELIEF PORTS LOCATED 600 mm ABOVE DESIGN WATER LEVEL.

SEAL FOR COFFERDAM

NOT TO SCALE

NOTES:

1. ** – Thickness of concrete seal based on hydraulic uplift figured to bottom of seal. Can reduce thickness by weight of piles and pile friction.*
2. *When piles are not required or when scouring is probable, steel sheeting shall be left in place and anchored to seal with Z bars. Indicate the elevation of where the sheeting shall be cut off on the plans.*
3. *For tidal areas, use the average of observed high tides for seal design.*
4. *Adequate embedment shall be provided below the bottom of seal to prevent boiling. Engineer shall check for interference between cofferdam sheeting and battered piles.*

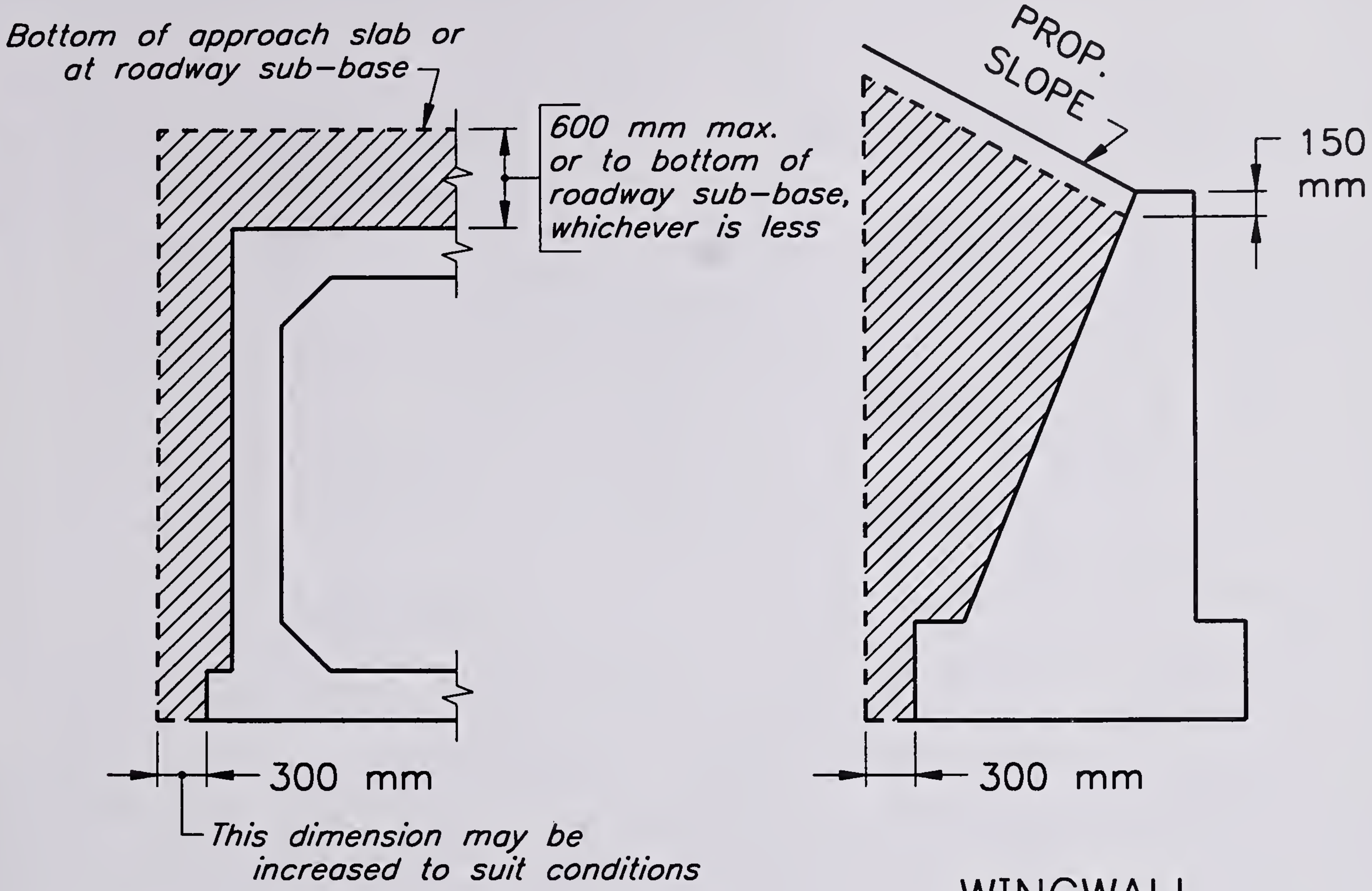
Plot Scale = 1:50

MASS HIGHWAY
BRIDGE MANUAL

COFFERDAM DETAILS
FOUNDATIONS AND FILL

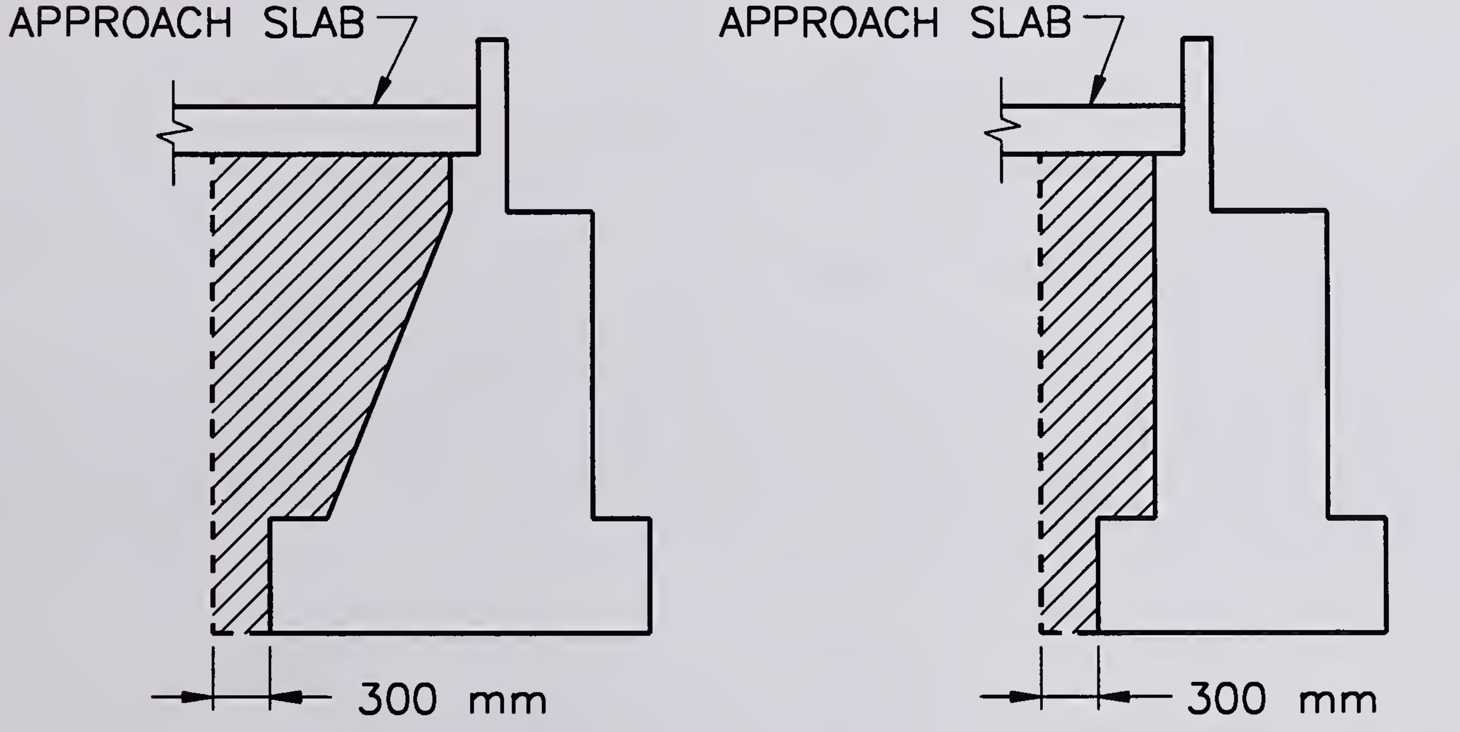
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
3.6.9


Bottom of approach slab or at roadway sub-base
600 mm max. or to bottom of roadway sub-base, whichever is less
300 mm
This dimension may be increased to suit conditions
PROP. SLOPE
150 mm
300 mm

BOX CULVERT
(OR FRAME)

WINGWALL



ABUTMENT

STUB ABUTMENT

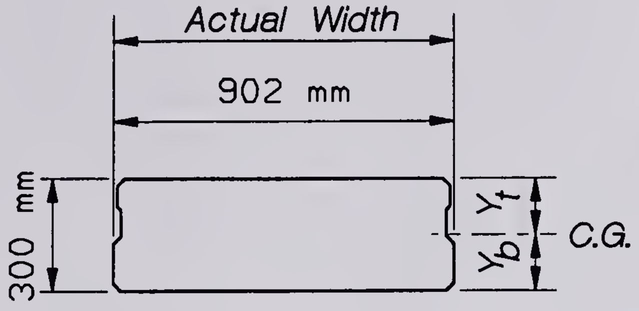
NOTE: HATCHED AREA INDICATES LIMITS OF GRAVEL BORROW

LIMITS OF GRAVEL BORROW

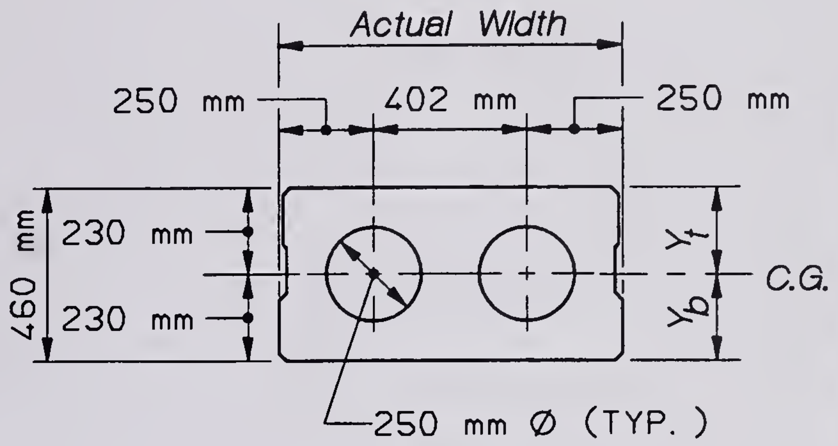
NOT TO SCALE

MASSHIGHWAY BRIDGE MANUAL	LIMITS OF GRAVEL BORROW FOUNDATIONS AND FILL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **3.6.10**

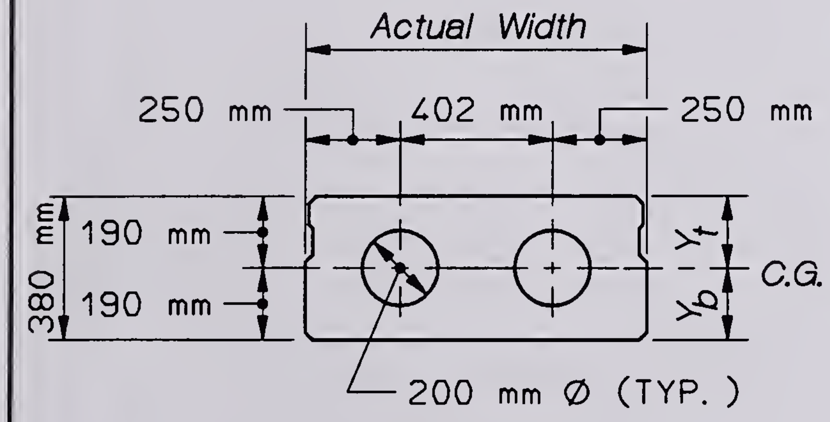
Plot Scale = 1:50



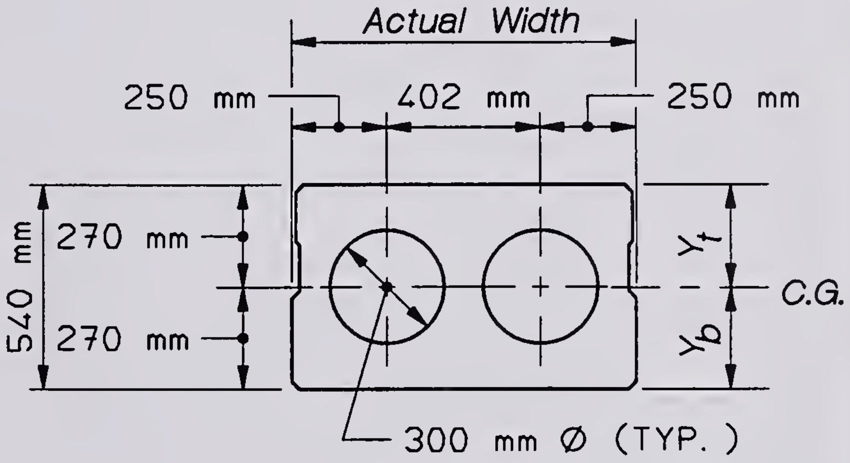
SI-900



SIII-900



SII-900



SIV-900

BEAM PROPERTIES:

BEAM TYPE	WIDTH		DEPTH	A	I	Y_b	Y_t	S_b	S_t	MASS	MAX. SPAN
	Nom. (mm)	Act. (mm)	(mm)	(mm^2)	(mm^4) x1.0E9	(mm)	(mm)	(mm^3) x1.0E6	(mm^3) x1.0E6	(kg/m)	(m)
SI-900	920	902	300	264800	1.988	148.984	151.016	13.344	13.164	636	9
SII-900	920	902	380	274130	3.885	188.290	191.710	20.633	20.265	659	12
SIII-900	920	902	460	307450	6.805	228.332	231.668	29.803	29.374	739	14
SIV-900	920	902	540	336410	10.840	267.465	272.535	40.529	39.775	808	17

NOTES:

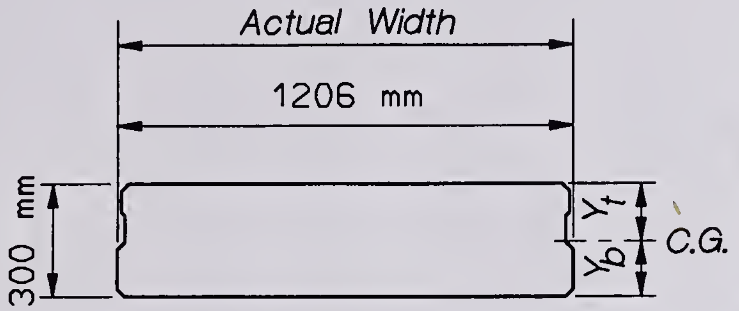
1. Above drawings are not to scale.
2. All four corners of each beam have 20 mm chamfers.
3. See Dwg. No. 4.1.6 for the shear key details.
4. Maximum span lengths are approximate.
5. Weight of beams do not include the weight of the solid sections located at the transverse ties. Use the total weight (including solid sections) for design.

MASS HIGHWAY
BRIDGE
MANUAL

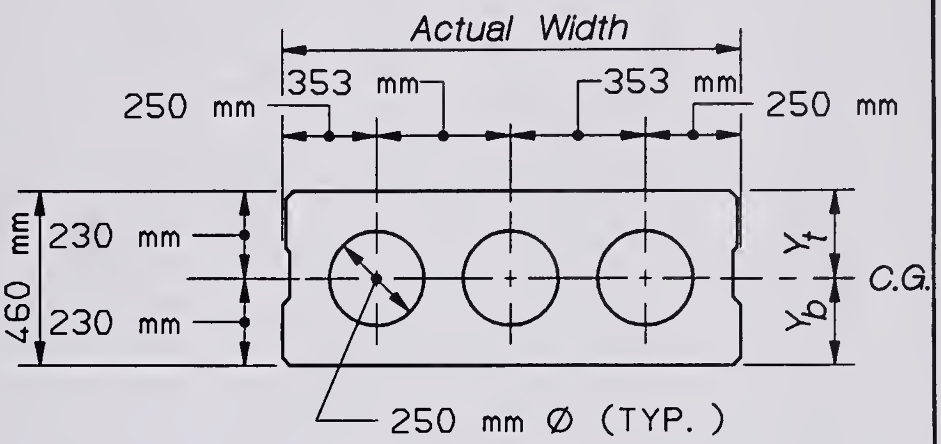
STANDARD 900 SERIES BEAMS
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

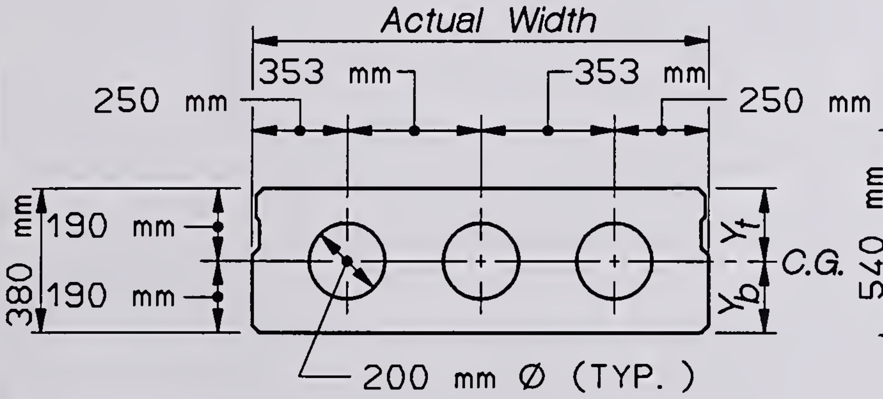
DRAWING NUMBER
4.1.1



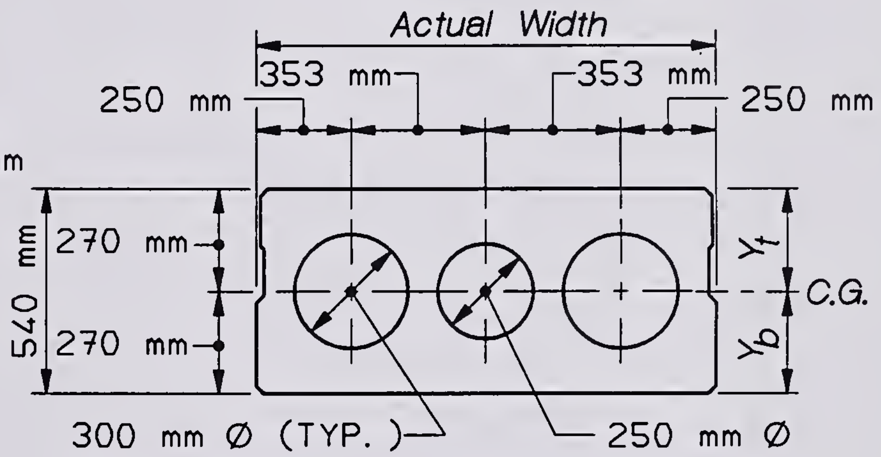
SI-1200



SIII-1200



SII-1200



SIV-1200

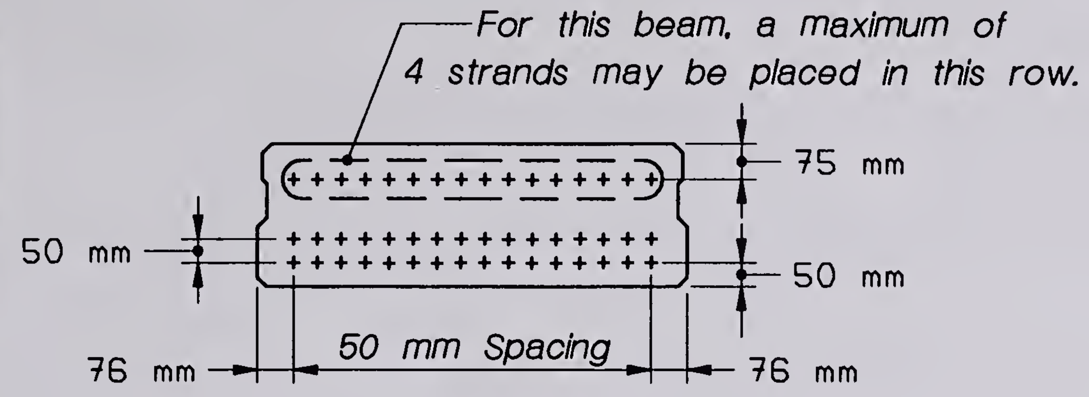
BEAM PROPERTIES:

BEAM TYPE	WIDTH		DEPTH (mm)	A (mm^2)	I (mm^4) x1.0E9	Y_b (mm)	Y_t (mm)	S_b (mm^3) x1.0E6	S_t (mm^3) x1.0E6	MASS (kg/m.)	MAX. SPAN (m)
	Nom. (mm)	Act. (mm)									
SI-1200	1220	1206	300	356000	2.672	149.245	150.755	17.903	17.724	855	9
SII-1200	1220	1206	380	358230	5.197	188.691	191.309	27.542	27.165	861	12
SIII-1200	1220	1206	460	398200	9.080	228.713	231.287	39.700	39.258	957	14
SIV-1200	1220	1206	540	451480	14.640	268.111	271.889	54.604	53.846	1085	17

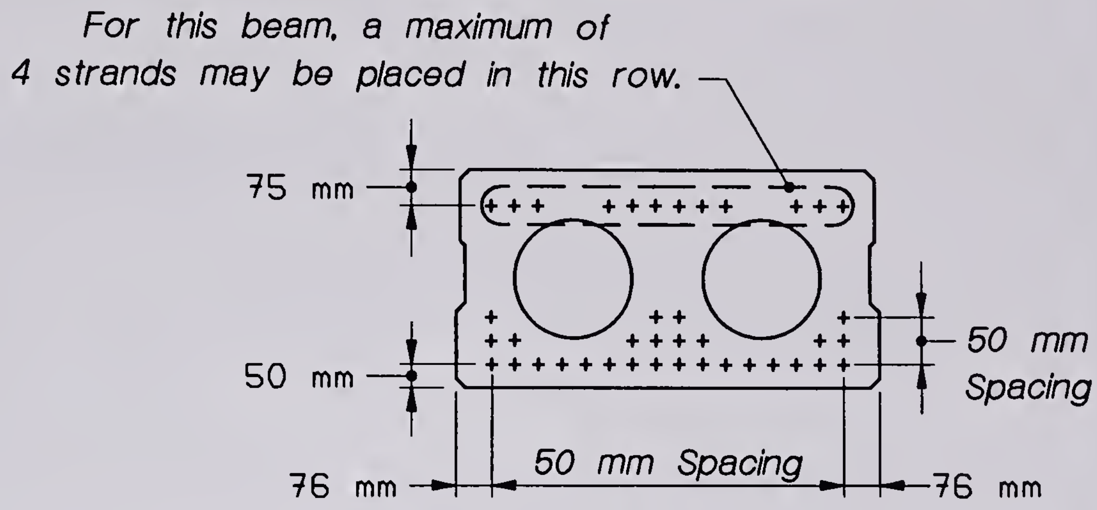
NOTES:

1. Above drawings are not to scale.
2. All four corners of each beam have 20 mm chamfers.
3. See Dwg. No. 4.1.6 for the shear key details.
4. Maximum span lengths are approximate.
5. Weight of beams do not include the weight of the solid sections located at the transverse ties. Use the total weight (including the solid sections) for design.

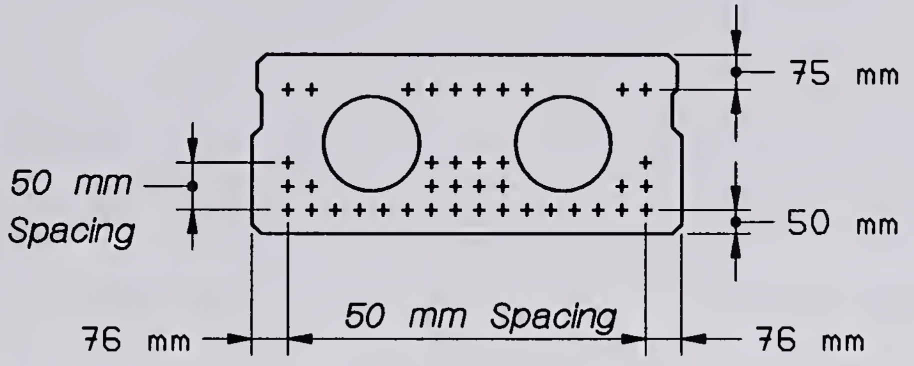
MASS HIGHWAY BRIDGE MANUAL	STANDARD 1200 SERIES BEAMS PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.1.2


For this beam, a maximum of 4 strands may be placed in this row.
75 mm
50 mm
50 mm
76 mm
50 mm Spacing
76 mm

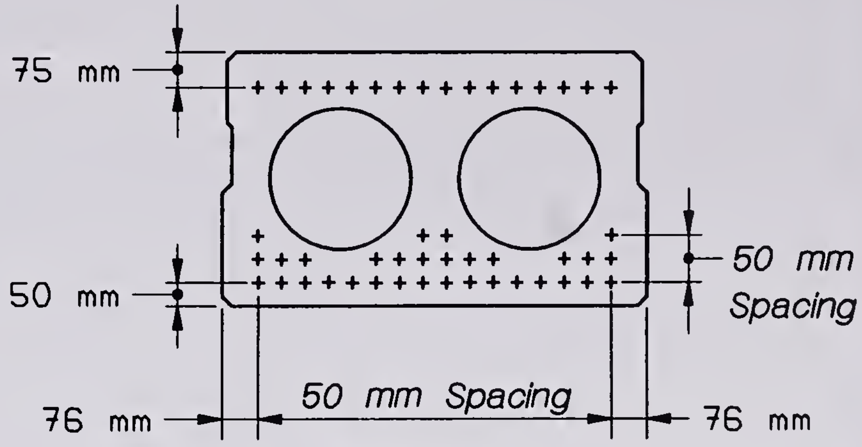
SI-900


For this beam, a maximum of 4 strands may be placed in this row.
75 mm
50 mm
50 mm Spacing
76 mm
50 mm Spacing
76 mm

SIII-900



SII-900



SIV-900

STRAND LOCATION

NOT TO SCALE

NOTES:

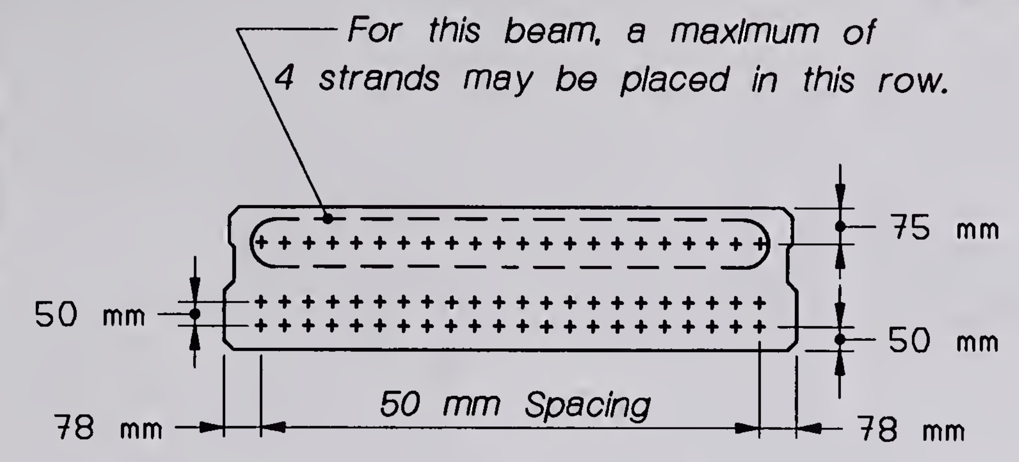
1. The standard strand pattern shown above depicts the maximum number of strands possible that can be located in a given beam while still meeting applicable fabrication clearances and tolerances. For most beam designs, strands shall be placed in as many locations within the pattern as required. If a particular beam design requires the placement of strands outside this pattern, the designer shall be responsible for verifying the beam's constructibility and its conformance to AASHTO requirements.
2. + Denotes straight strands.
3. ⊕ Denotes debonded strands (none shown above). No more than 25% of the total number of strands may be debonded. The spacing between debonded strands must be at least 100 mm apart. Do not debond the outermost strands of each layer.

MASS HIGHWAY
BRIDGE
MANUAL

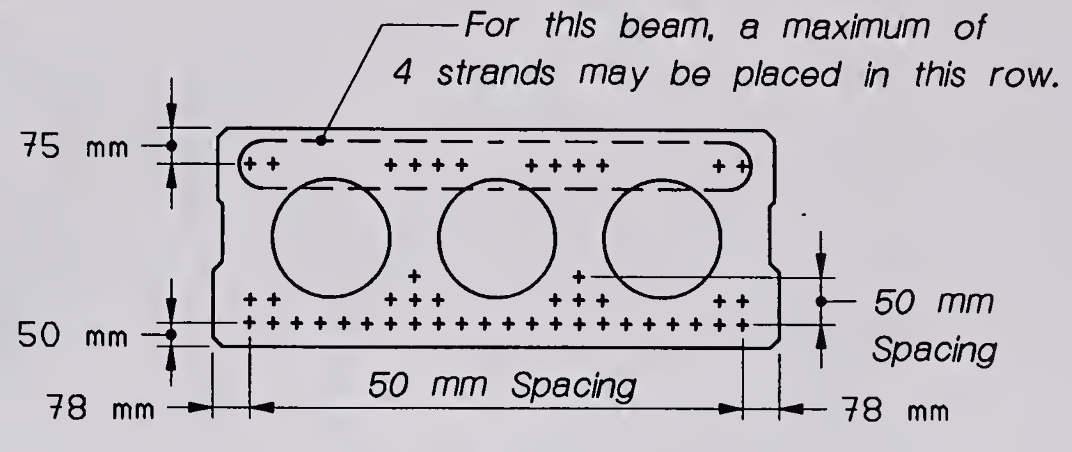
STANDARD STRAND LOCATION
900 SERIES BEAMS
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

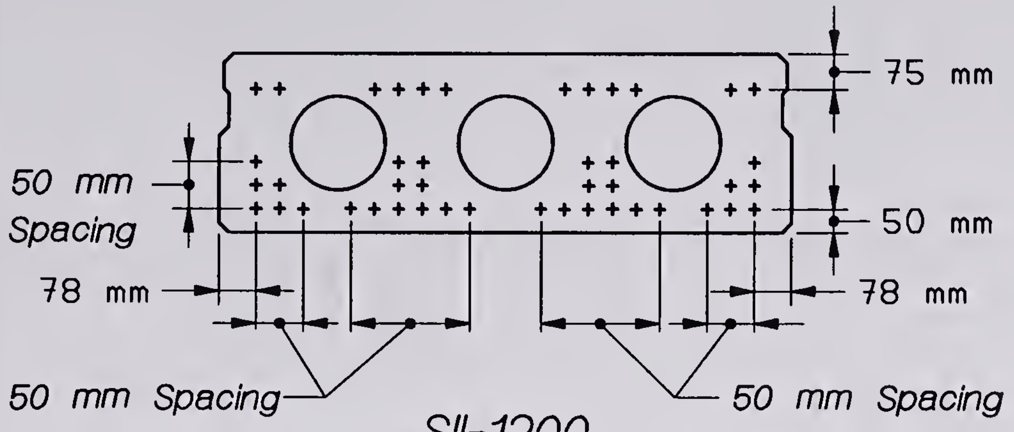
DRAWING NUMBER
4.1.3


For this beam, a maximum of 4 strands may be placed in this row.
75 mm
50 mm
50 mm
78 mm
50 mm Spacing
78 mm

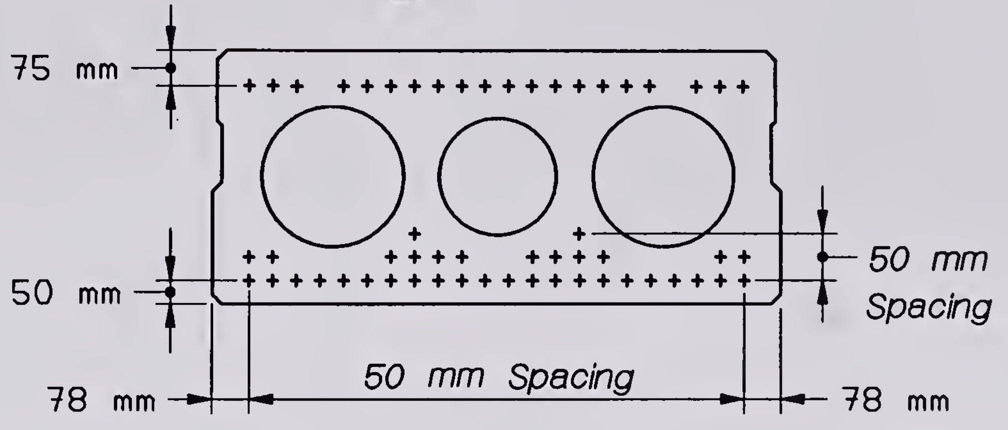
SI-1200


For this beam, a maximum of 4 strands may be placed in this row.
75 mm
50 mm
50 mm Spacing
78 mm
50 mm Spacing
78 mm

SIII-1200



SII-1200



SIV-1200

STRAND LOCATION

NOT TO SCALE

NOTES:

1. The standard strand pattern shown above depicts the maximum number of strands possible that can be located in a given beam while still meeting applicable fabrication clearances and tolerances. For most beam designs, strands shall be placed in as many locations within the pattern as required. If a particular beam design requires the placement of strands outside this pattern, the designer shall be responsible for verifying the beam's constructibility and its conformance to AASHTO requirements.
2. + Denotes straight strands.
3. ⊕ Denotes debonded strands (none shown above). No more than 25% of the total number of strands may be debonded. The spacing between debonded strands must be at least 100 mm apart. Do not debond the outermost strands of each layer.

MASS HIGHWAY
BRIDGE
MANUAL

STANDARD STRAND LOCATION
1200 SERIES BEAMS
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.4

PRESTRESS NOTES:

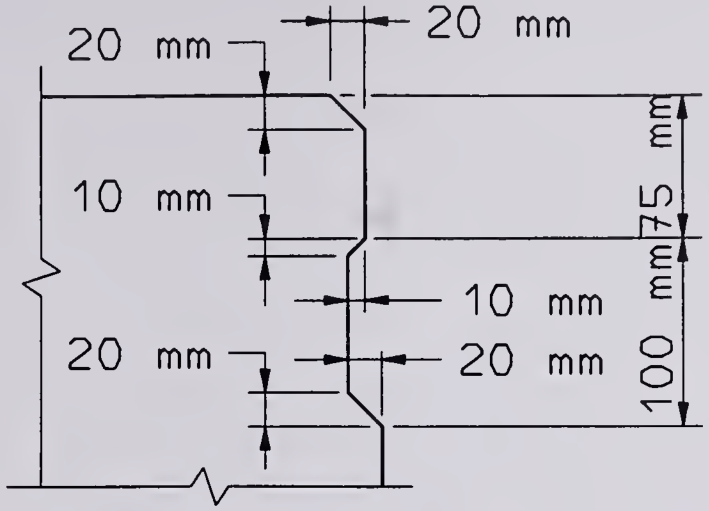
1. ALL PRETENSIONING ELEMENTS SHALL BE 13 mm Ø, UNCOATED, SEVEN-WIRE, LOW RELAXATION STEEL STRANDS AND SHALL CONFORM TO AASHTO M203.
2. THE MINIMUM ULTIMATE TENSILE STRENGTH OF THE PRETENSIONING STRANDS SHALL BE 1860 MPa.
3. THE INITIAL TENSION PER 13 mm Ø STRAND SHALL BE XXXXX kN.
4. THE MINIMUM 28 DAY COMPRESSIVE STRENGTH SHALL BE 45 MPa. *(See Note 1 below.)*
5. NO PRESTRESS SHALL BE TRANSFERRED TO THE CONCRETE UNTIL IT HAS ATTAINED A COMPRESSIVE STRENGTH, AS SHOWN BY A CYLINDER TEST, OF AT LEAST 28 MPa. *(See Note 1 below.)*
6. THE TOP OF ALL BEAMS SHALL BE GIVEN A SMOOTH FINISH EXCEPT AS NOTED ON THE PLANS. *(See Note 2 below.)*
7. THE FABRICATOR IS FULLY RESPONSIBLE FOR THE DESIGN OF THE LIFTING DEVICES WHICH SHALL BE ADEQUATE FOR THE SAFETY FACTORS REQUIRED BY THE ERECTION PROCEDURE.

NOTES:

1. *The designer may increase the 28 day compressive strength of the concrete and/or the compressive strength at transfer if justified and feasible. See the prestressed concrete section of Part I of the Bridge Manual.*
2. *The designer shall note on the construction plans a raked finish for the tops of the prestressed beams in the areas under the sidewalks, curbs, and concrete barriers.*

MASS HIGHWAY BRIDGE MANUAL	PRESTRESS NOTES PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.1.5**

FOR TYPE SI & TYPE SII BEAMS:



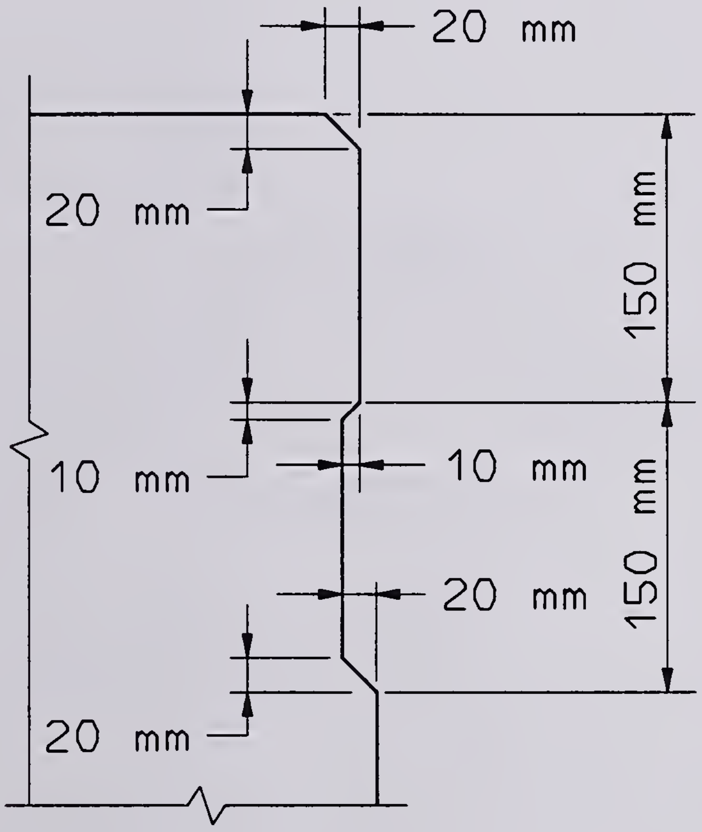
NOTE:

DEPTH OF SHEAR KEY VARIES AT TRANSVERSE TIE LOCATIONS. *(See Dwg. No. 4.1.17.)*

SHEAR KEY DETAIL

SCALE 1:5

FOR TYPE SIII & TYPE SIV BEAMS:



NOTE:

DEPTH OF SHEAR KEY VARIES AT TRANSVERSE TIE LOCATIONS. *(See Dwg. No. 4.1.17.)*

SHEAR KEY DETAIL

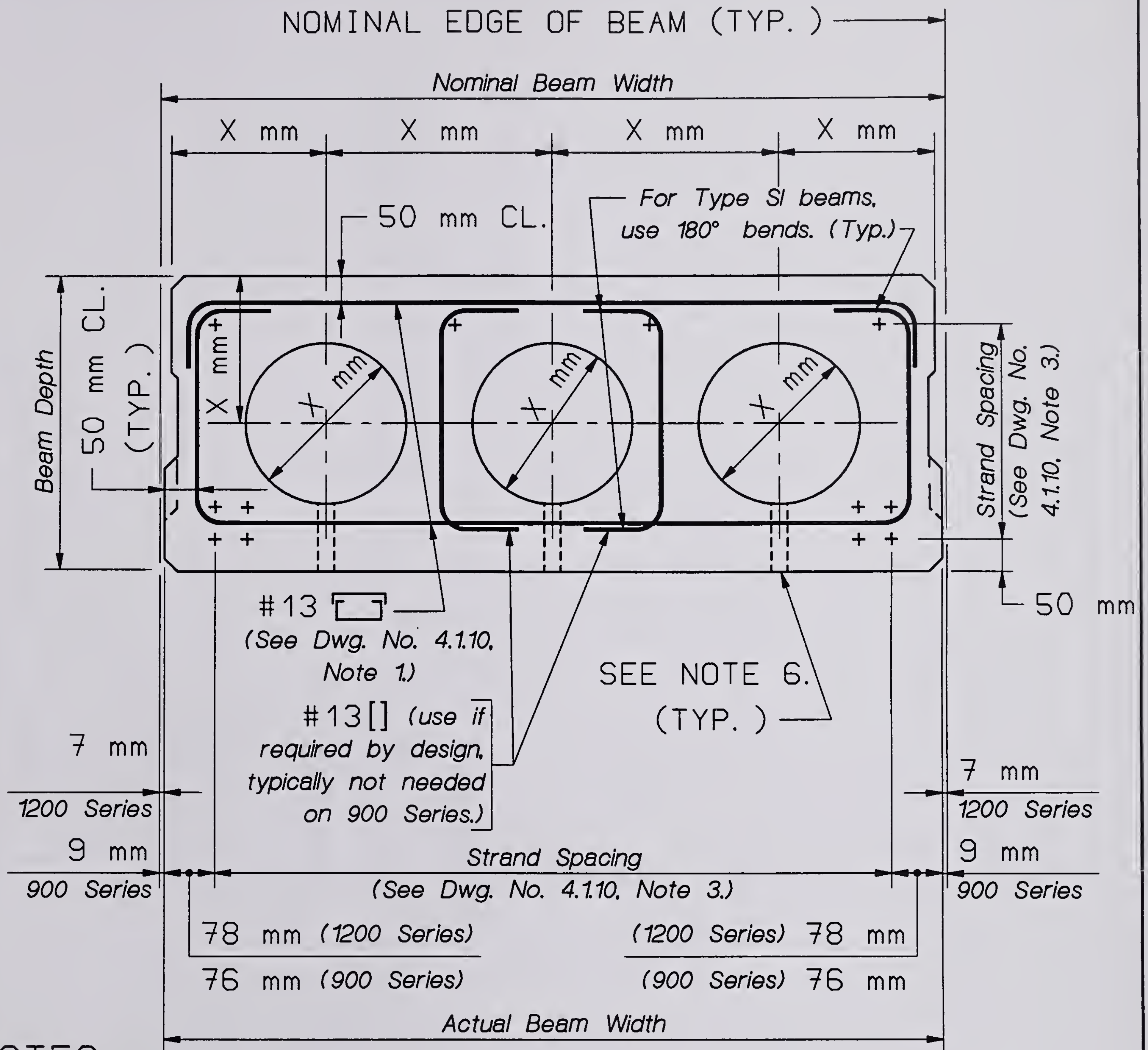
SCALE 1:5

MASS HIGHWAY
BRIDGE
MANUAL

SHEAR KEY DETAILS
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.6



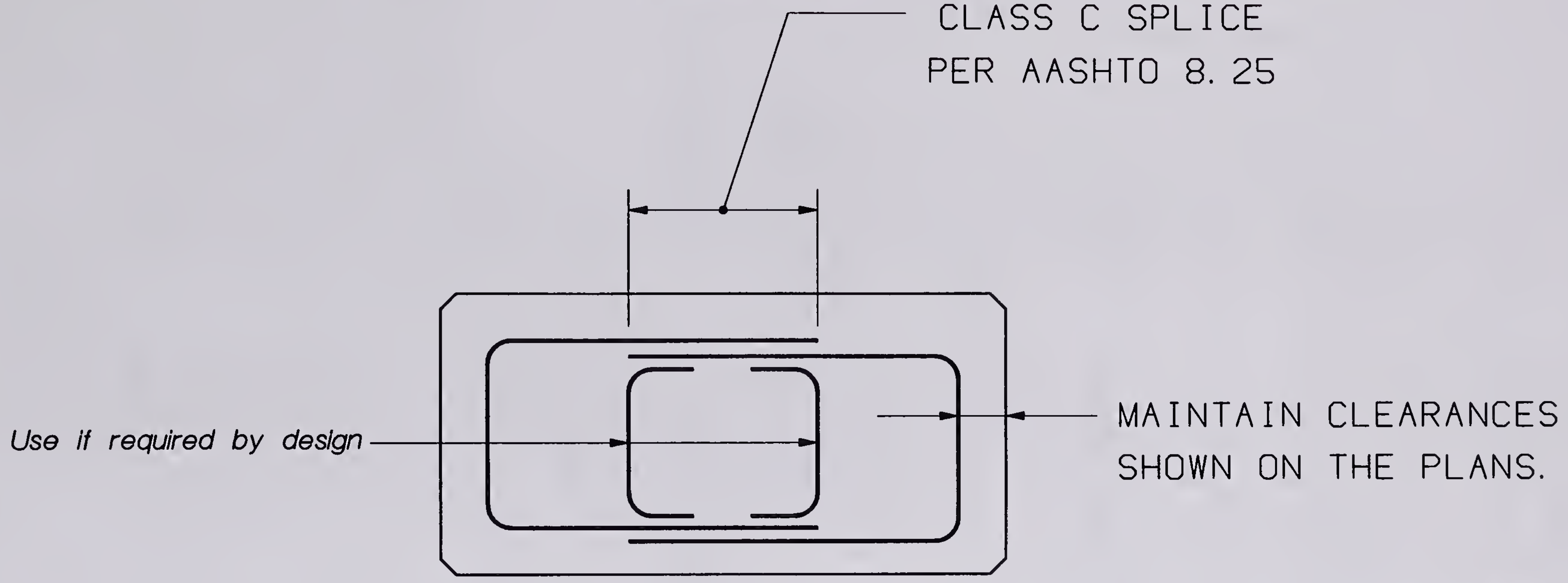
NOTES:

1. + DENOTES STRAIGHT STRANDS.
2. ⊕ DENOTES DEBONDED STRANDS.
3. SEE SHEAR KEY DETAIL ON SHEET X.
4. SEE END OF BEAM PLAN FOR STIRRUP SPACING.
5. ALL FOUR CORNERS OF BEAM SHALL HAVE 20 mm CHAMFERS.
6. 25 mm Ø DRAIN, PLACE AT LOW POINT OF VOIDS.

MIDSPAN SECTION

SCALE 1: 10

MASS HIGHWAY BRIDGE MANUAL	TYPICAL MIDSPAN SECTION PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.1.7**



NOTE:

CONTRACTOR MAY SUBMIT ABOVE STIRRUP PATTERN TO THE ENGINEER FOR APPROVAL PROVIDED THAT THE ABOVE CRITERIA ARE MET.

ALTERNATIVE STIRRUP PATTERN

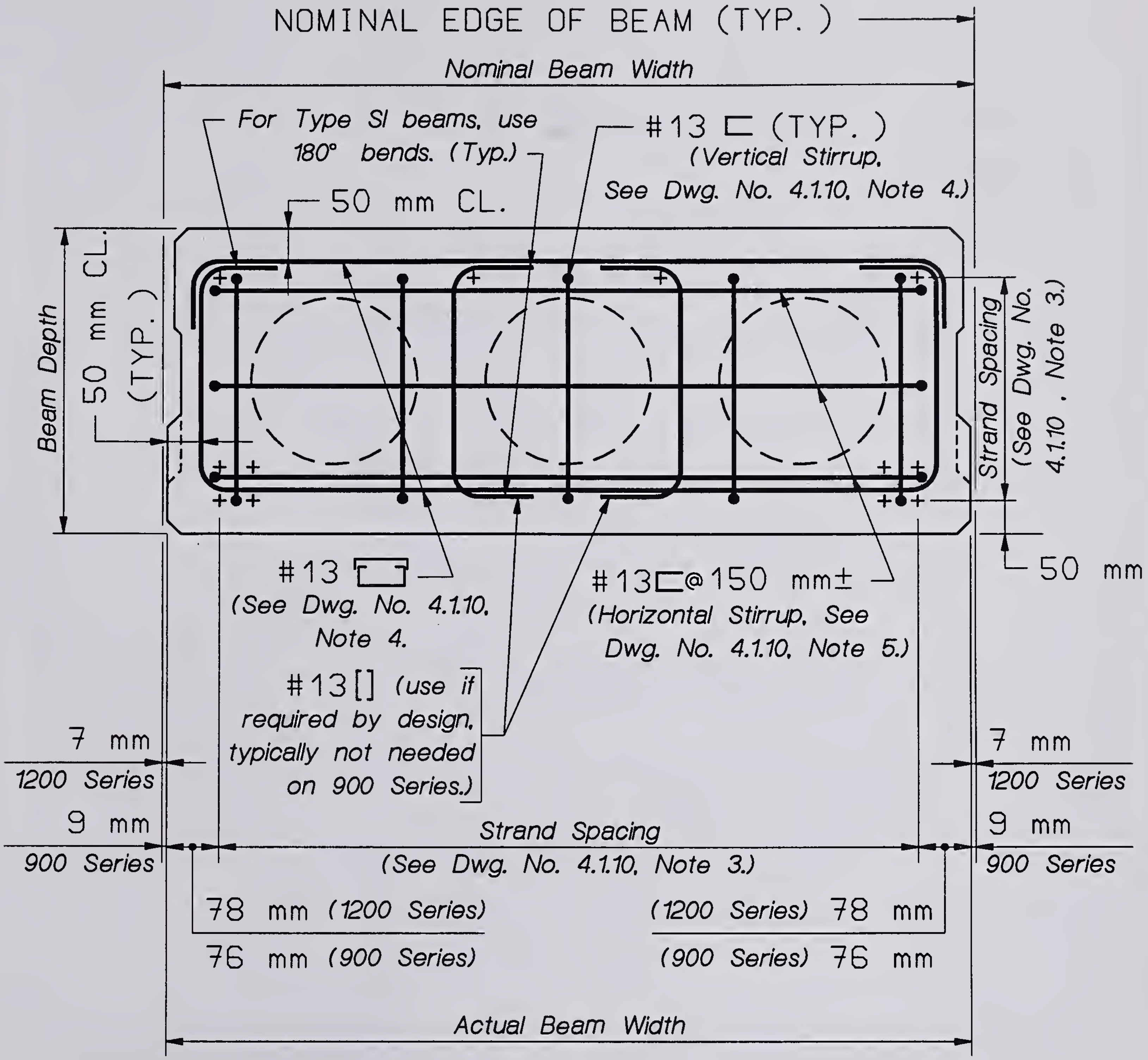
NOT TO SCALE

MASSHIGHWAY
BRIDGE
MANUAL

ALTERNATIVE STIRRUP
PATTERN
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.8


NOMINAL EDGE OF BEAM (TYP.)
Nominal Beam Width
For Type SI beams, use 180° bends. (Typ.)
#13 ⊏ (TYP.) (Vertical Stirrup, See Dwg. No. 4.1.10, Note 4.)
50 mm CL.
Beam Depth
50 mm CL. (TYP.)
Strand Spacing (See Dwg. No. 4.1.10 , Note 3.)
50 mm
#13 (See Dwg. No. 4.1.10, Note 4.
#13⊏@150 mm± (Horizontal Stirrup, See Dwg. No. 4.1.10, Note 5.)
#13[] (use if required by design, typically not needed on 900 Series.)
7 mm
1200 Series
9 mm
900 Series
7 mm
1200 Series
9 mm
900 Series
Strand Spacing (See Dwg. No. 4.1.10, Note 3.)
78 mm (1200 Series)
76 mm (900 Series)
(1200 Series) 78 mm
(900 Series) 76 mm
Actual Beam Width

NOTES:

1. + DENOTES STRAIGHT STRANDS.
2. ⊕ DENOTES DEBONDED STRANDS.
3. SEE SHEAR KEY DETAIL ON SHEET X.
4. SEE PLAN OF END OF BEAM FOR STIRRUP SPACING.
5. ALL FOUR CORNERS OF BEAM SHALL HAVE 20 mm CHAMFERS.

END OF BEAM SECTION

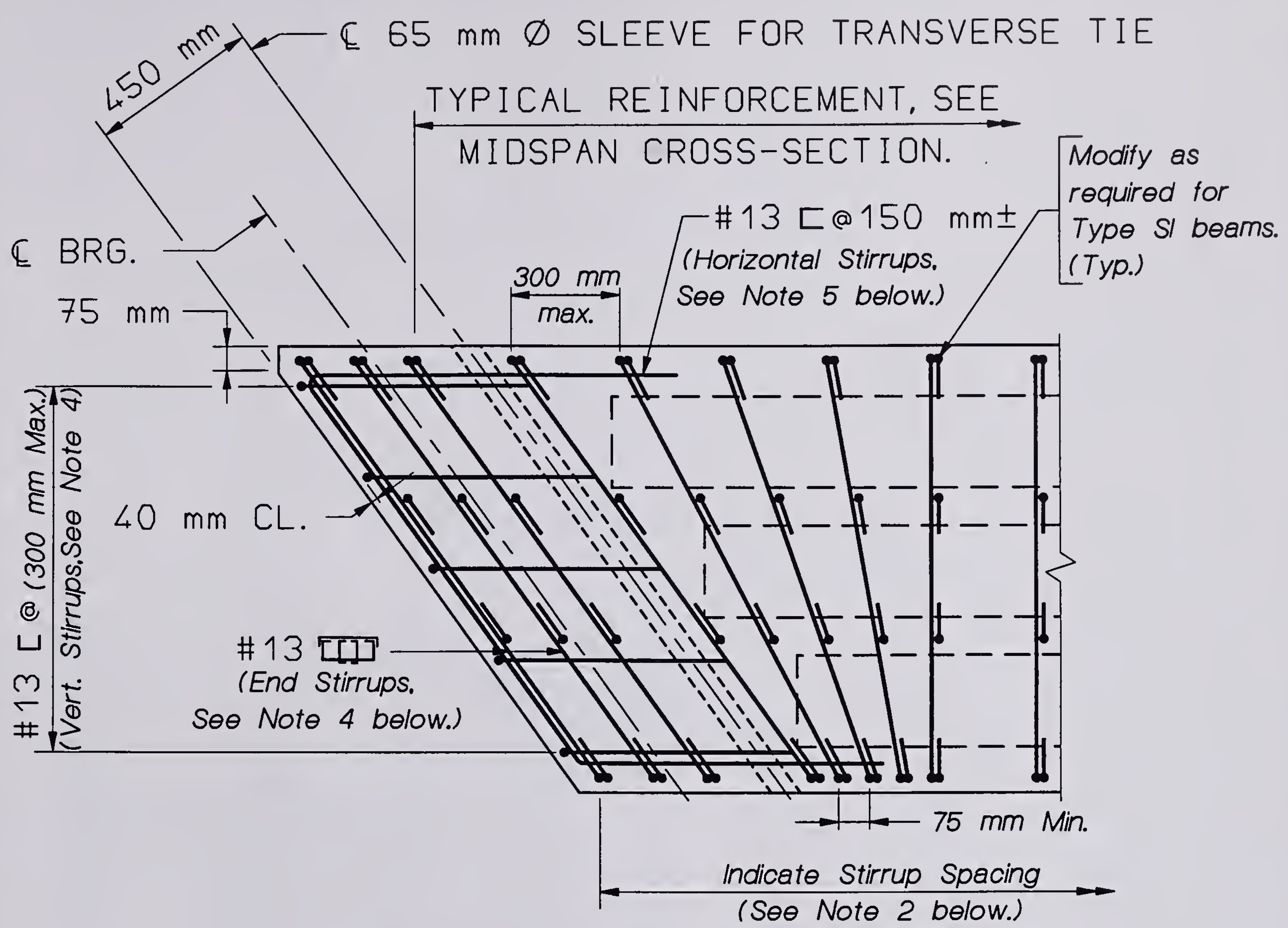
SCALE 1:10

MASS HIGHWAY
BRIDGE
MANUAL

TYP. END OF BEAM SECTION
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.9


℄ 65 mm Ø SLEEVE FOR TRANSVERSE TIE
450 mm
TYPICAL REINFORCEMENT, SEE MIDSPAN CROSS-SECTION.
Modify as required for Type SI beams. (Typ.)
#13 ⊏@150 mm±
(Horizontal Stirrups, See Note 5 below.)
300 mm max.
℄ BRG.
75 mm
#13 ⊏ @ (300 mm Max.)
(Vert. Stirrups,See Note 4)
40 mm CL.
#13
(End Stirrups, See Note 4 below.)
75 mm Min.
Indicate Stirrup Spacing
(See Note 2 below.)

END OF BEAM PLAN

SCALE 1:20

NOTES:

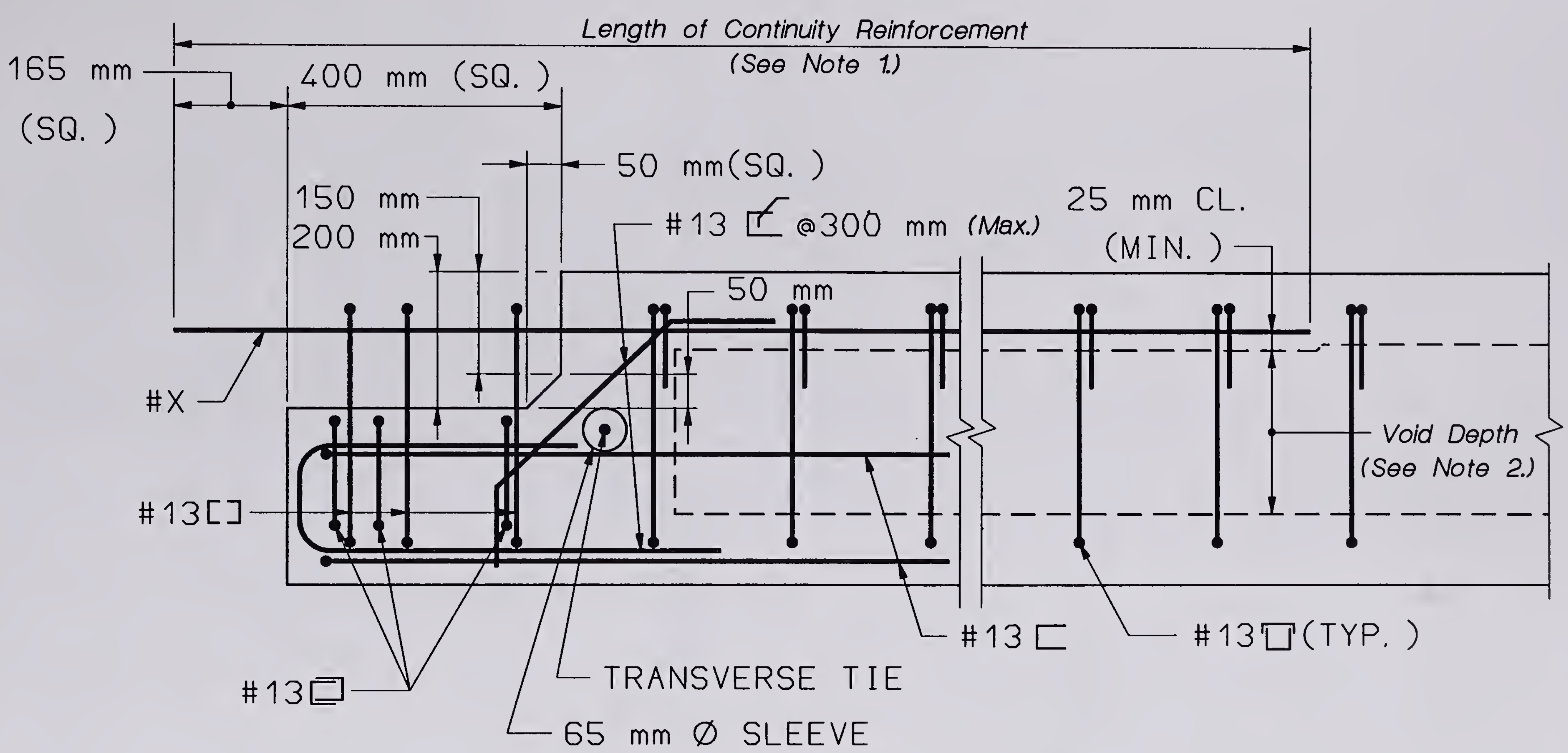
1. See the prestressed section of Part I of the Bridge Manual for the design of the transverse stirrups. Spacing shall not exceed 300 mm.
2. The extent of the beam shown in the Plan of End of Beam should be long enough to indicate typical stirrup spacing throughout the beam.
3. The actual number and location of the prestressed strands shall be designed and shall conform to the spacings shown in Dwg. Nos. 4.1.3 and 4.1.4.
4. See the prestressed section of Part I of the Bridge Manual for the design of the end transverse stirrups and vertical stirrups. The horizontal legs of the vertical stirrups are equal to the depth of the beam and shall be dimensioned on the plan view.
5. Horizontal stirrups shall be embedded a minimum distance equal to the depth of the beam or 300 mm into the web of the voided section, whichever is longer. Length of embedment shall be noted on the plan view.
6. Properly note or show the location and spacing of any dowels which extend into slabs, sidewalks, curbs, or barriers on the cross-section and plan views of the beams.

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL END OF BEAM PLAN
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.10



LONGITUDINAL SECTION (WITH BLOCK-OUT)

SCALE 1: 10

NOTES:

1. The length, size and quantity of continuity reinforcement shall be determined by the designer. See the prestressed section of Part I of the Bridge Manual for design guidelines. Do not include continuity reinforcement if block-out section is for placing a joint system.
2. The depth of the internal void may be decreased in order to maintain the required clearances between the continuity reinforcement and voids.

MASS HIGHWAY
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LONG. SECTION W/ BLOCK-OUT
(SIII & SIV ONLY)
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

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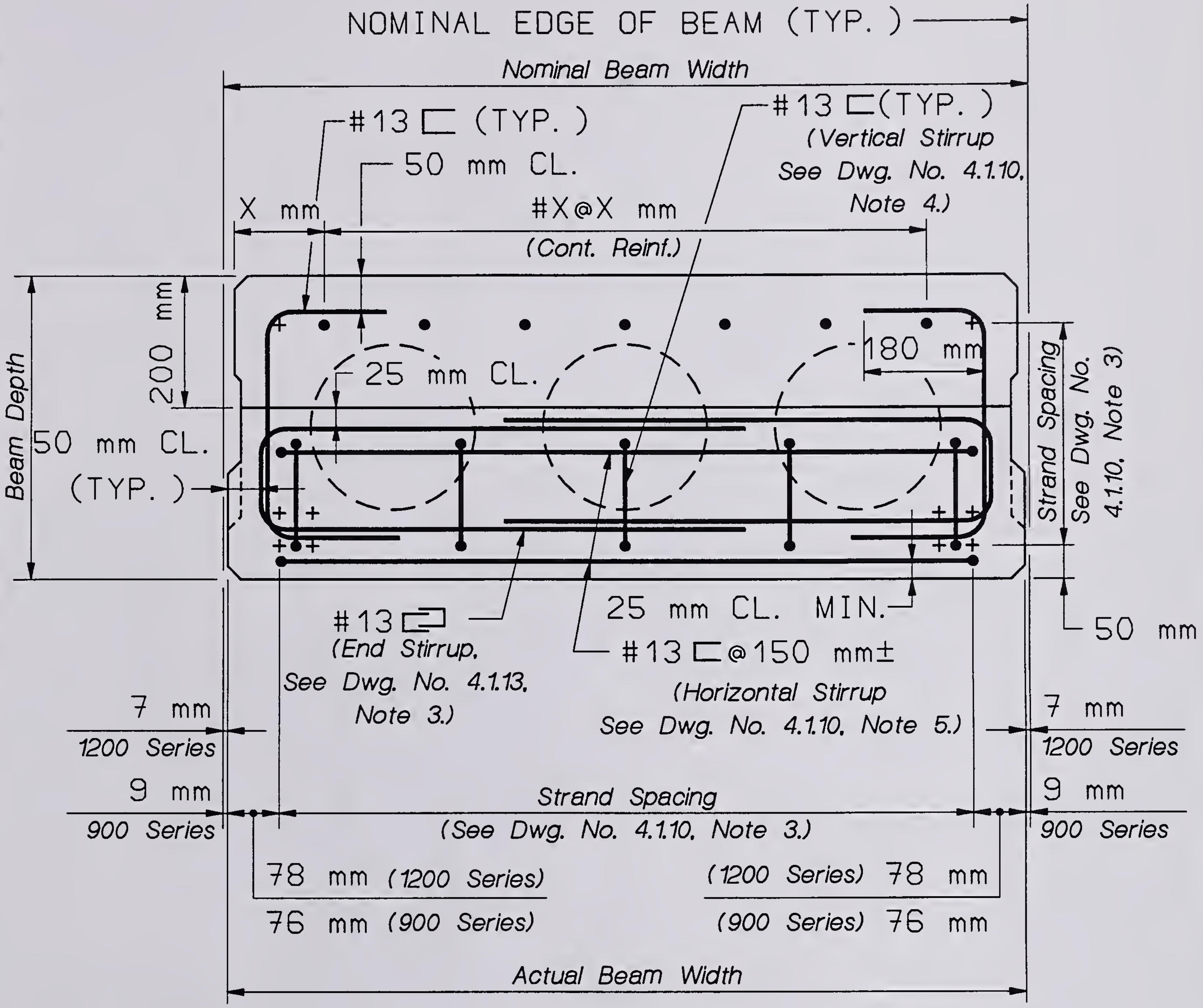
4.1.11



NOTES:

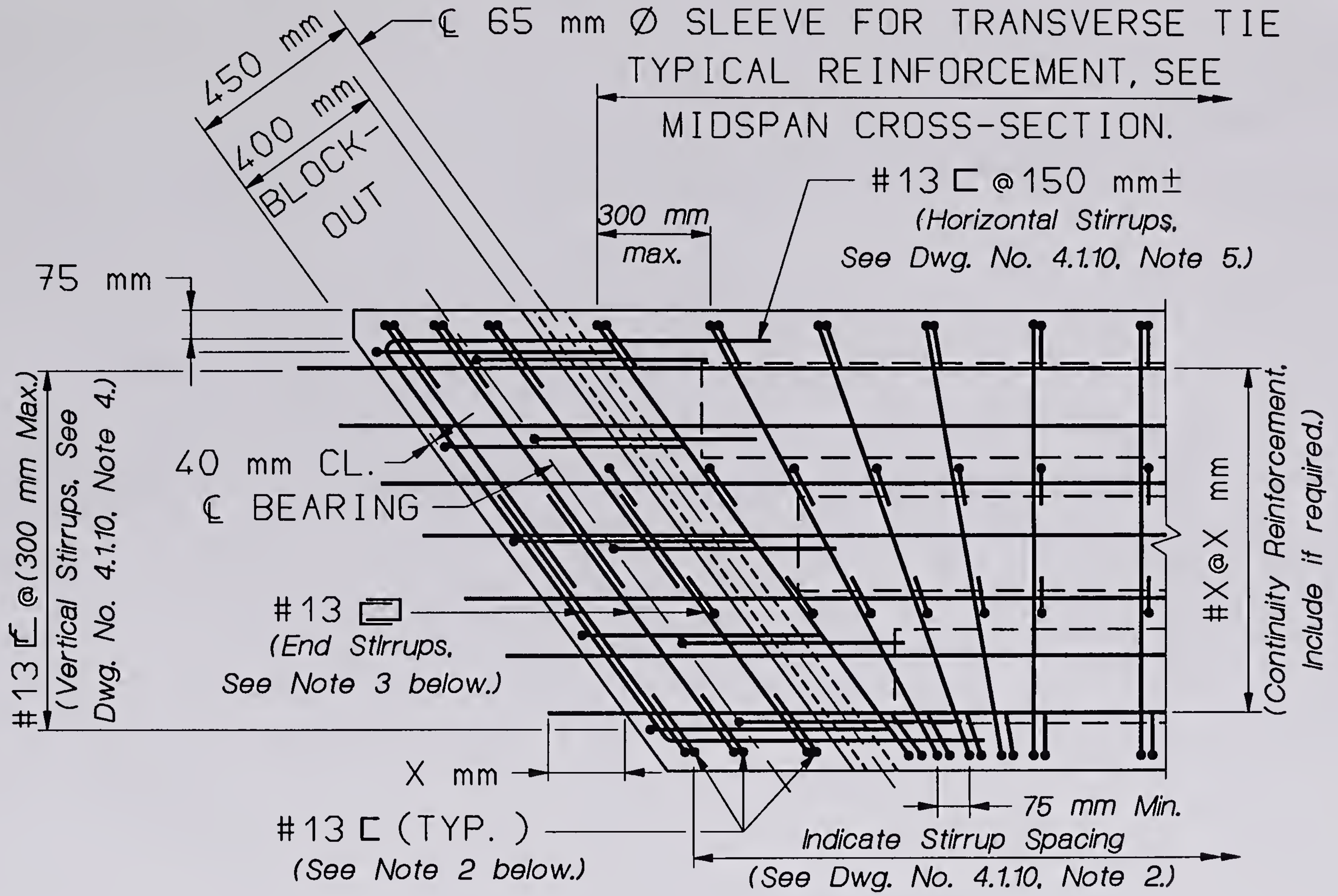
1. + DENOTES STRAIGHT STRANDS.
2. ⊕ DENOTES DEBONDED STRANDS.
3. SEE SHEAR KEY DETAIL ON SHEET X.
4. SEE END OF BEAM PLAN FOR STIRRUP SPACING.
5. ALL FOUR CORNERS OF BEAM SHALL HAVE 20 mm CHAMFERS.

END OF BEAM SECTION

(WITH BLOCK-OUT)

SCALE 1:10

MASS HIGHWAY BRIDGE MANUAL	END OF BEAM SECTION W/ BLOCK-OUT(SIII & SIV ONLY) PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.1.12**


℄ 65 mm Ø SLEEVE FOR TRANSVERSE TIE
TYPICAL REINFORCEMENT, SEE MIDSPAN CROSS-SECTION.
450 mm
400 mm
BLOCK-OUT
75 mm
300 mm max.
#13 ⊏ @150 mm±
(Horizontal Stirrups, See Dwg. No. 4.1.10, Note 5.)
#13 ⊏ @(300 mm Max.)
(Vertical Stirrups, See Dwg. No. 4.1.10, Note 4.)
40 mm CL.
℄ BEARING
#13 ▭
(End Stirrups, See Note 3 below.)
X mm
#13 ⊏ (TYP.)
(See Note 2 below.)
75 mm Min.
Indicate Stirrup Spacing
(See Dwg. No. 4.1.10, Note 2.)
#X@X mm
(Continuity Reinforcement, Include if required.)

END OF BEAM PLAN (WITH BLOCK-OUT)

SCALE 1:20

NOTES:

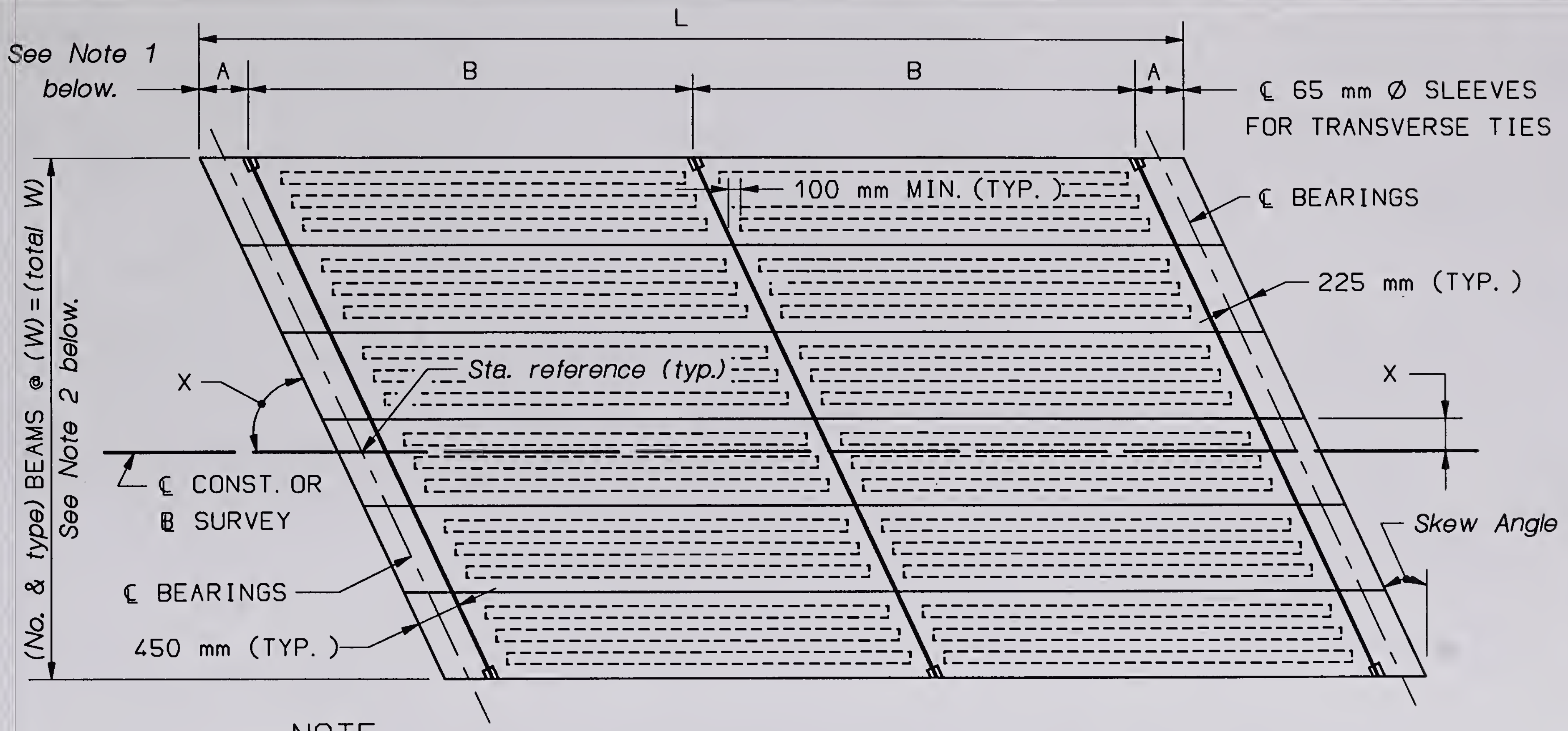
1. Block-out sections may be utilized for placing a joint system or for beam continuity. Provide a plan view of each end of beam unless they are identical.
2. If block-out section is for continuity, provide #13 ⊏ bars to meet shear requirements. If block-out section is for a joint system, provide a minimum of 4-#13 ⊏ bars.
3. End stirrups located 1/4 of the beam depth from the end shall be designed as indicated on Dwg. No. 4.1.10, Note 4. All other stirrups in the block-out section shall be designed as transverse stirrups, see Dwg. No. 4.1.10, Note 1.
4. See Dwg. No. 4.1.10 Note 6.

MASS HIGHWAY
BRIDGE
MANUAL

END OF BEAM PLAN W/
BLOCK-OUT(SIII & SIV ONLY)
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.13



NOTE:
SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.

FRAMING PLAN *(SKEW ≤ 30°)*

SCALE (1:100 *min.*)

NOTES:

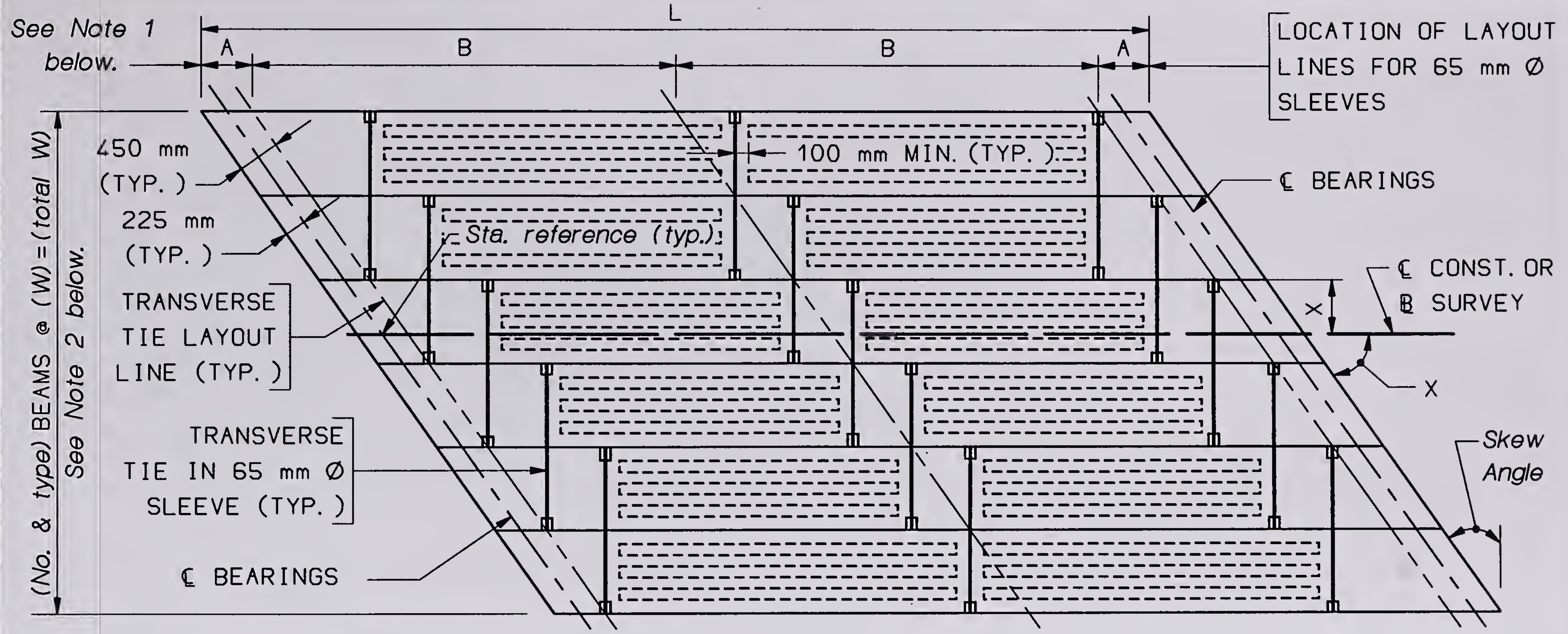
1. *A - 450 mm/COS(Skew Angle)*
   L - Span Length + A
   B - (L/2) - A
2. *Specifiy beam type (e.g. SI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).*
3. *Framing plan shall be drawn full length without breaks and to scale on the construction plans. Show all internal voids and transverse ties and include north arrow.*
4. *If torsional load in the fascia beams (due to sidewalk overhang or utilities) is excessive, consideration will be given to increasing the number of lateral strands and/or post-tensioning and adjust transverse tie locations as necessary.*

MASS HIGHWAY
BRIDGE
MANUAL

FRAMING PLAN (SKEW ≤ 30°)
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.14



NOTE:

SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.

FRAMING PLAN *(SKEW > 30°)*

SCALE (1: 100 *min.*)

NOTES:

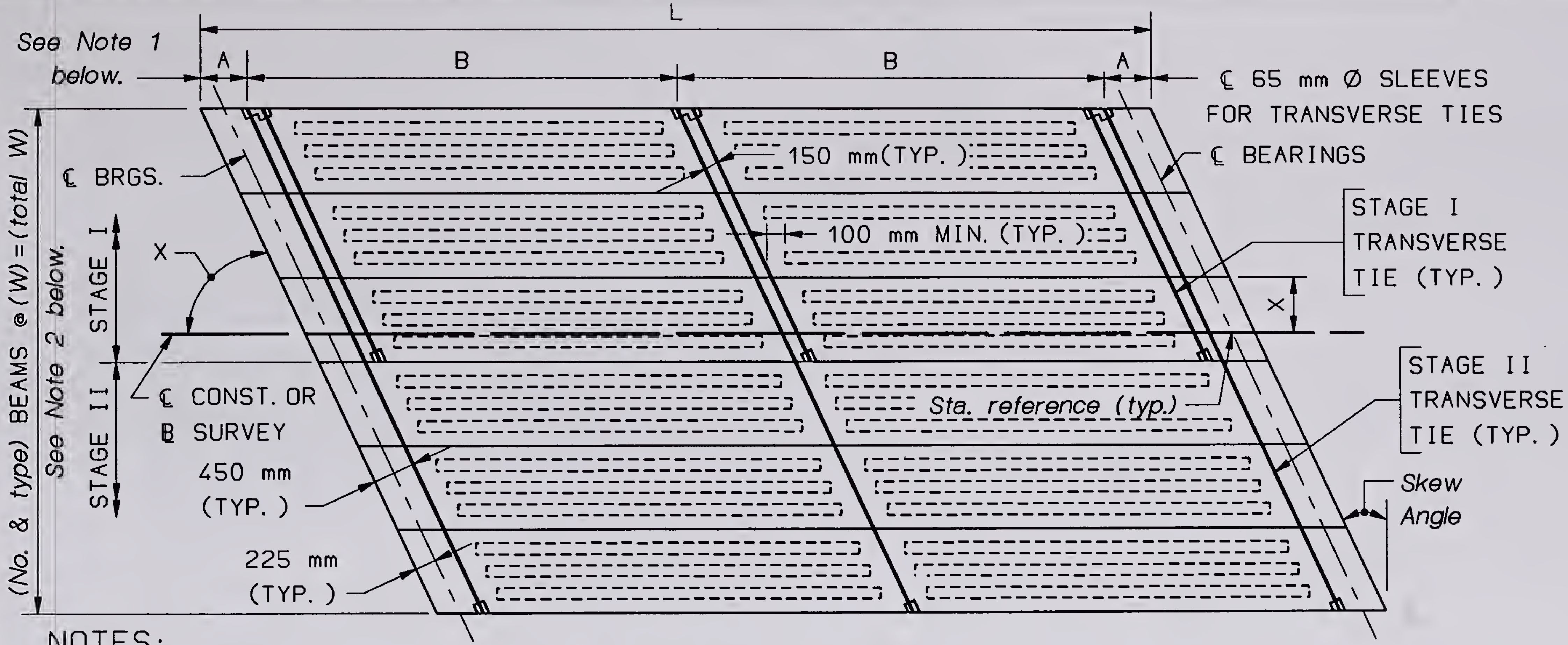
1. *A = 450 mm/COS(Skew Angle)*
   L = Span Length + A
   B = (L/2) - A
2. *Specify beam type (e.g. SI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).*
3. *Framing plan shall be drawn full length without breaks and to scale on the construction plans. Show all internal voids and transverse ties and include north arrow.*
4. *If torsional load in the fascia beams (due to sidewalk overhang or utilities) is excessive, consideration will be given to increasing the number of lateral strands and/or post-tensioning and adjust transverse tie locations as necessary.*

MASSHIGHWAY
BRIDGE
MANUAL

FRAMING PLAN (SKEW > 30°)
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.15



NOTES:

1. SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.
2. STAGE I: AFTER ERECTING STAGE I BEAMS, INSTALL AND TENSION TRANSVERSE TIES IN STAGE I SLEEVES.
3. STAGE II: AFTER ERECTING STAGE II BEAMS, INSTALL AND TENSION TRANSVERSE TIES IN STAGE II SLEEVES FULL WIDTH OF BRIDGE.

FRAMING PLAN (STAGE CONSTRUCTION (SKEW ≤ 30°)

SCALE 1: 100

NOTES:

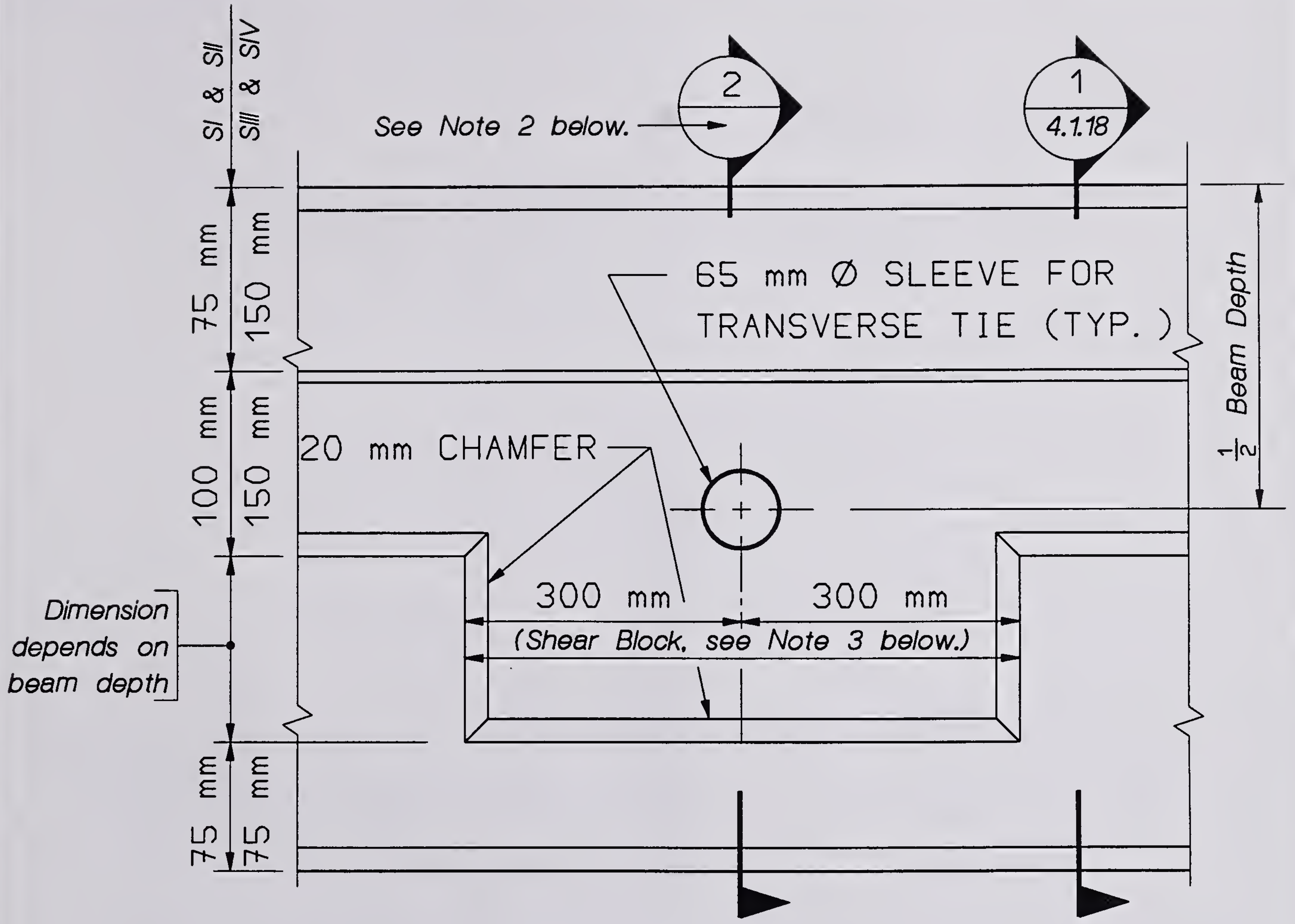
1. A = 450 mm/COS(Skew Angle)
   L = Span Length + A
   B = (L/2) - A
2. Specify beam type (e.g. SI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).
3. Framing plan shall be drawn full length without breaks and to scale on construction plans. Show all internal voids and include north arrow.
4. If torsional load in the fascia beams (due to sidewalk overhang or utilities) is excessive, consideration will be given to increasing the number of lateral strands and/or post-tensioning and adjust transverse tie locations as necessary.

MASS HIGHWAY
BRIDGE
MANUAL

FRAMING PLAN
STAGE CONSTRUCTION
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.16



TYPICAL BEAM ELEVATION AT TRANSVERSE TIE LOCATIONS

NOT TO SCALE

NOTES:

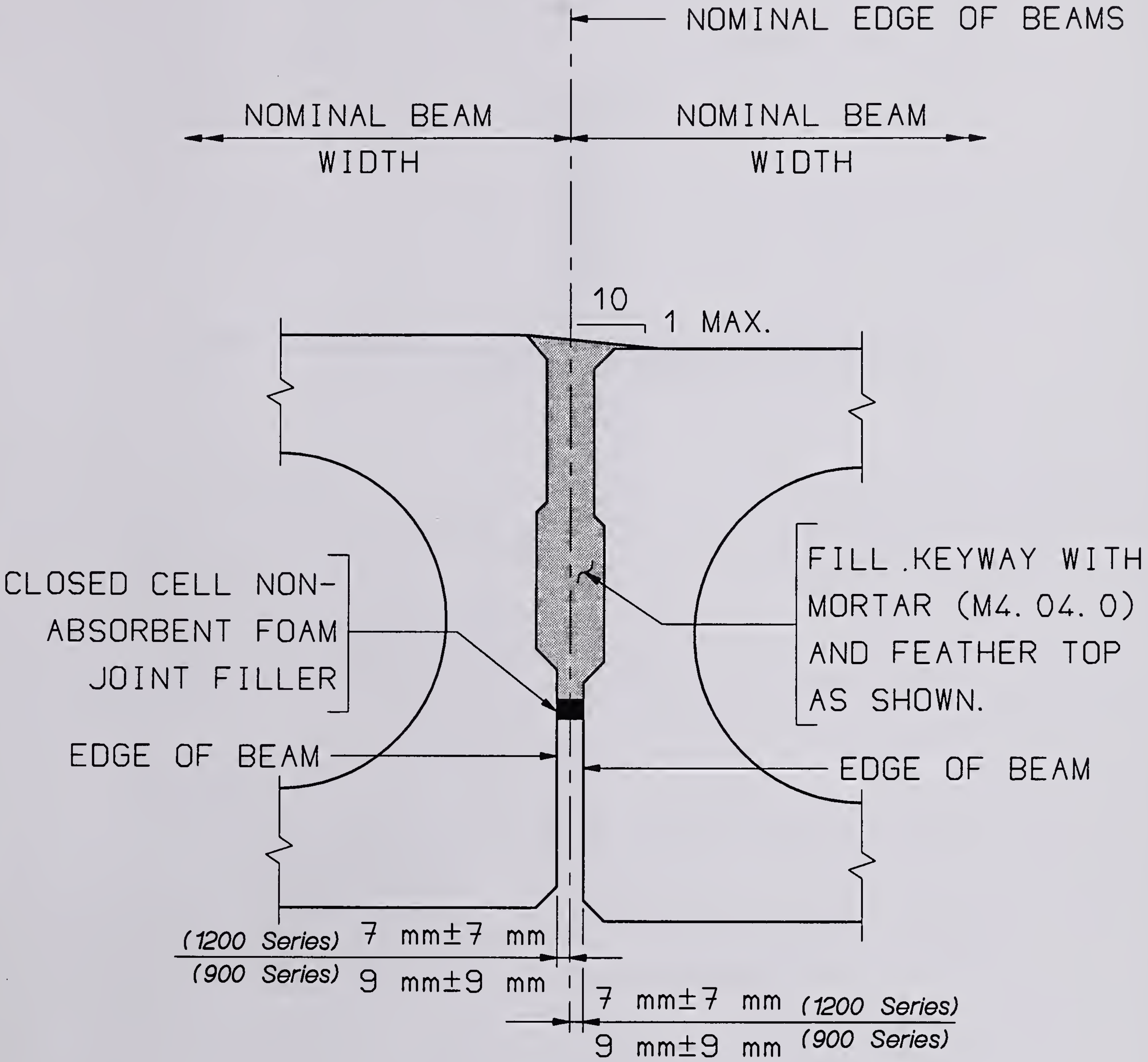
1. *Transverse ties are located at the midspan and at both ends of deck beams.*
2. *See Dwg. No. 4.1.19 for skews less than or equal to 30°. See Dwg. No. 4.1.21 for skews greater than 30°.*
3. *When two sets of ties are used for stage construction, the width of the shear block shall be increased by the longintudinal skew spacing of the two sleeves. Maintain 300 mm clearance from the center of sleeve to edge of shear block.*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL LONGITUDINAL JOINT
ELEVATION
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.17



SECTION 1

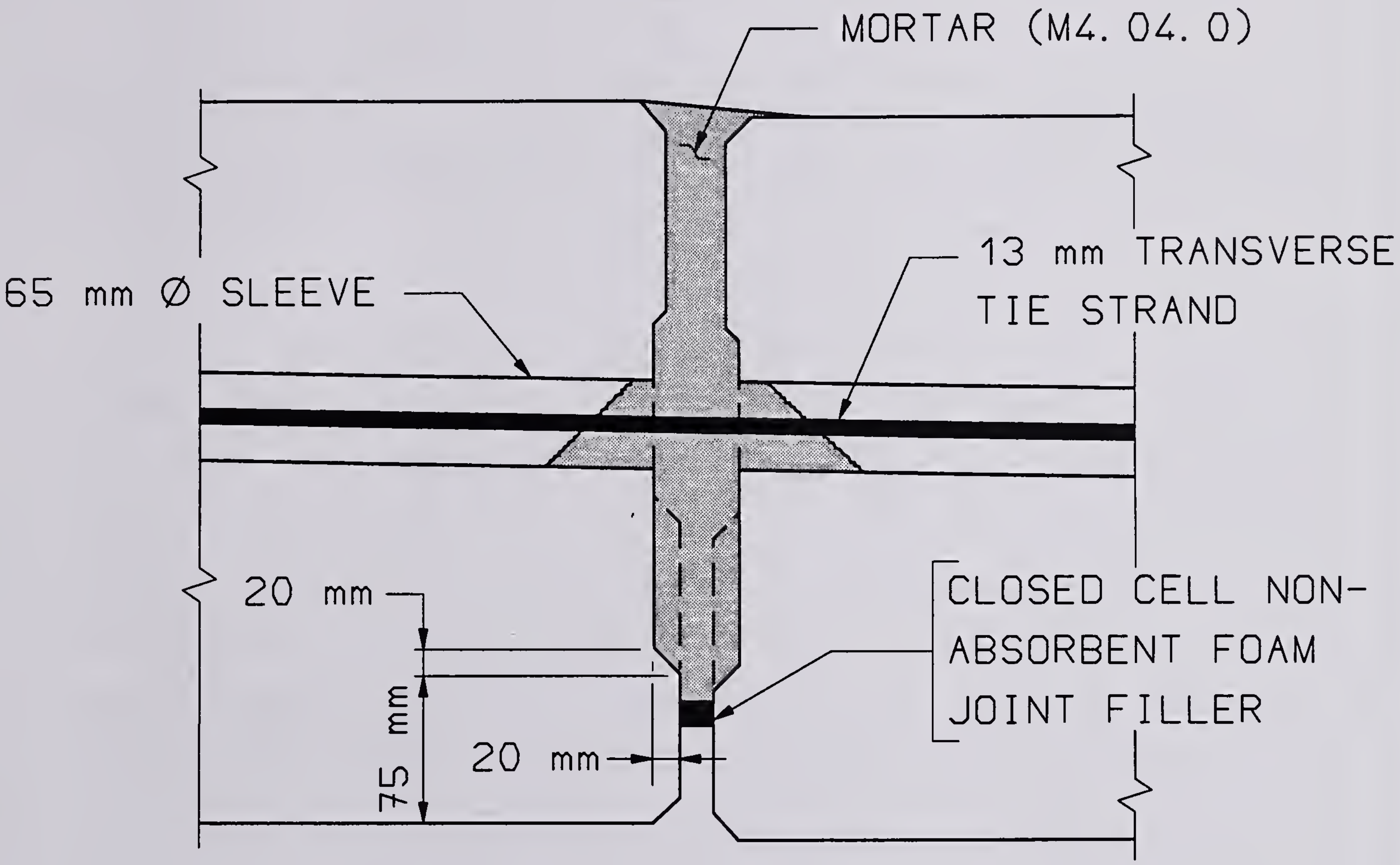
NOT TO SCALE

MASS HIGHWAY
BRIDGE MANUAL

TYPICAL LONGITUDINAL JOINT
SECTION
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.18


MORTAR (M4. 04. 0)
13 mm TRANSVERSE TIE STRAND
65 mm Ø SLEEVE
20 mm
CLOSED CELL NON-ABSORBENT FOAM JOINT FILLER
75 mm
20 mm

NOTES:

1. SEE SECTION 1 FOR JOINT DETAILS NOT SHOWN HERE.
2. SEE TRANSVERSE TIE TENSIONING NOTES FOR THE TENSIONING PROCEDURE.

SECTION 2 *(SKEW ≤ 30°)*

NOT TO SCALE

NOTE:
See Dwg. No. 4.1.21 for skews greater than 30°.

MASS HIGHWAY
BRIDGE
MANUAL

TRANSVERSE TIE DETAIL
SKEW ≤ 30°
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.19

FOR SKEWS ≤ 30°:

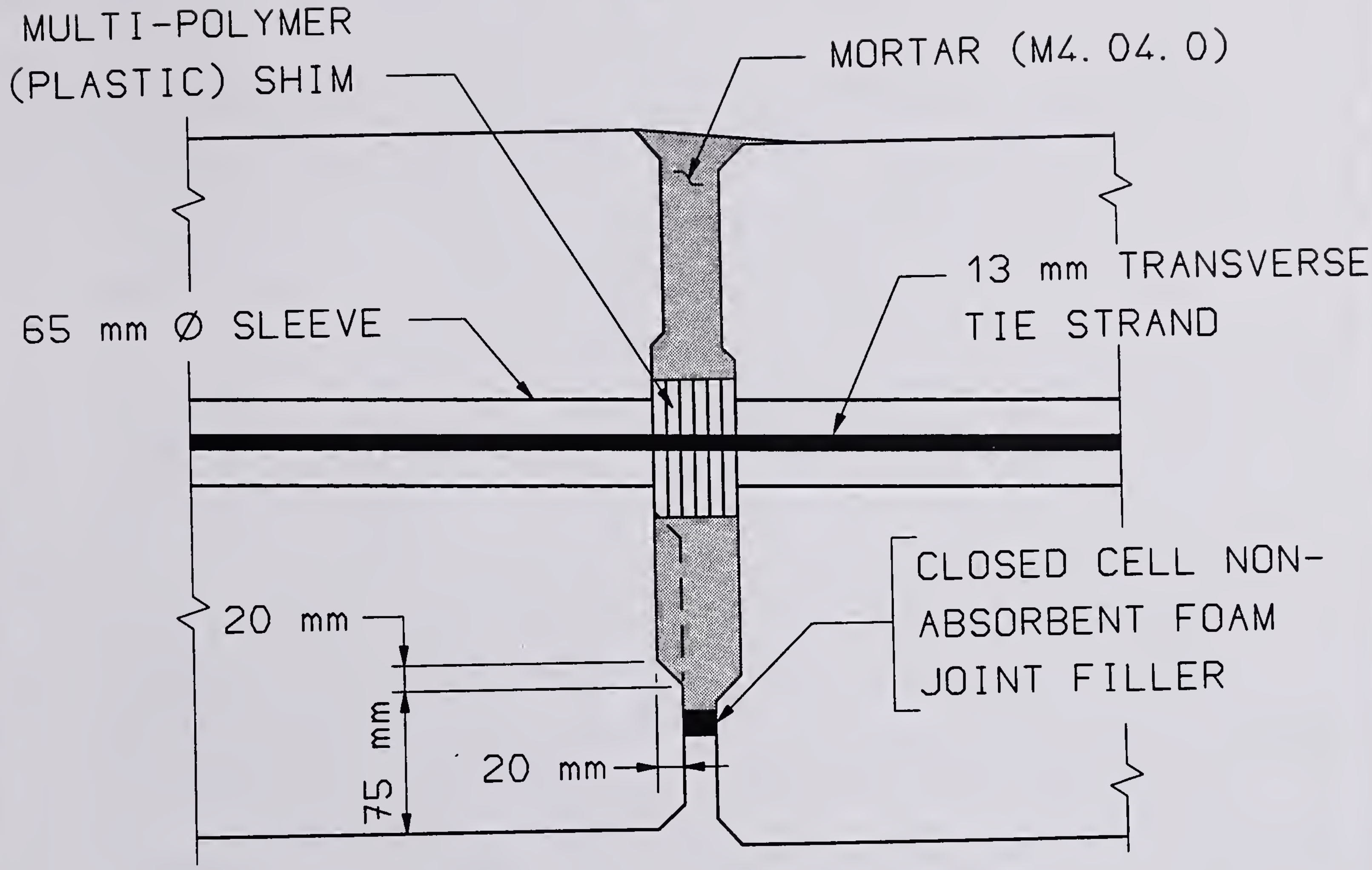
TRANSVERSE TIE TENSIONING NOTES:

1. AFTER ALL BEAMS HAVE BEEN ERECTED, TENSION EACH TRANSVERSE TIE TO 22 kN. *(See Note 3 below.)*
2. FILL ALL KEYWAYS WITH MORTAR (M4.04.0). IF THE KEYWAYS ARE NOT FILLED WITHIN FIVE DAYS AFTER THE BEAMS ARE ERECTED, THE CONTRACTOR SHALL COVER AND PROTECT THE KEYWAYS FROM THE WEATHER AND DEBRIS UNTIL THEY ARE FILLED.
3. AFTER THE MORTAR HAS CURED, TENSION EACH TRANSVERSE TIE TO 135 kN. NO TRAFFIC OR HEAVY EQUIPMENT WILL BE PERMITTED ON THE BEAMS UNTIL ALL TIES HAVE BEEN PROPERLY TENSIONED.
4. CONCRETE FOR SIDEWALK, CURB AND/OR BARRIER SECTIONS SHALL BE PLACED AFTER THE TRANSVERSE TIES HAVE BEEN FULLY TENSIONED.

NOTES:

1. *Adjust the above notes as necessary to conform to stage construction.*
2. *See Dwg. No. 4.1.22 for skews > 30°.*
3. *Where the total initial tensioning force of all the transverse ties is sufficient to displace the exterior beams, the designer shall modify these notes to require the placement of shims between beams. The designer shall specify the type, number, and location of these shims. The shims shall be placed between as many beams as is required such that the total initial tensioning force does not displace any beams.*

MASSHIGHWAY BRIDGE MANUAL	TRANSVERSE TIE TENSIONING NOTES, SKEW ≤ 30° PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.1.20**


MULTI-POLYMER (PLASTIC) SHIM
MORTAR (M4. 04. 0)
13 mm TRANSVERSE TIE STRAND
65 mm Ø SLEEVE
CLOSED CELL NON-ABSORBENT FOAM JOINT FILLER
20 mm
75 mm
20 mm

NOTES:

1. SEE SECTION 1 FOR JOINT DETAILS NOT SHOWN HERE.
2. SEE TRANSVERSE TIE TENSIONING NOTES FOR TENSIONING PROCEDURE.

SECTION 2 *(SKEW > 30°)*

NOT TO SCALE

NOTE:
See Dwg. No. 4.1.19 for skews less than or equal to 30° .

MASS HIGHWAY
BRIDGE
MANUAL

TRANSVERSE TIE DETAIL
SKEW > 30°
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.21

FOR SKEWS > 30° :

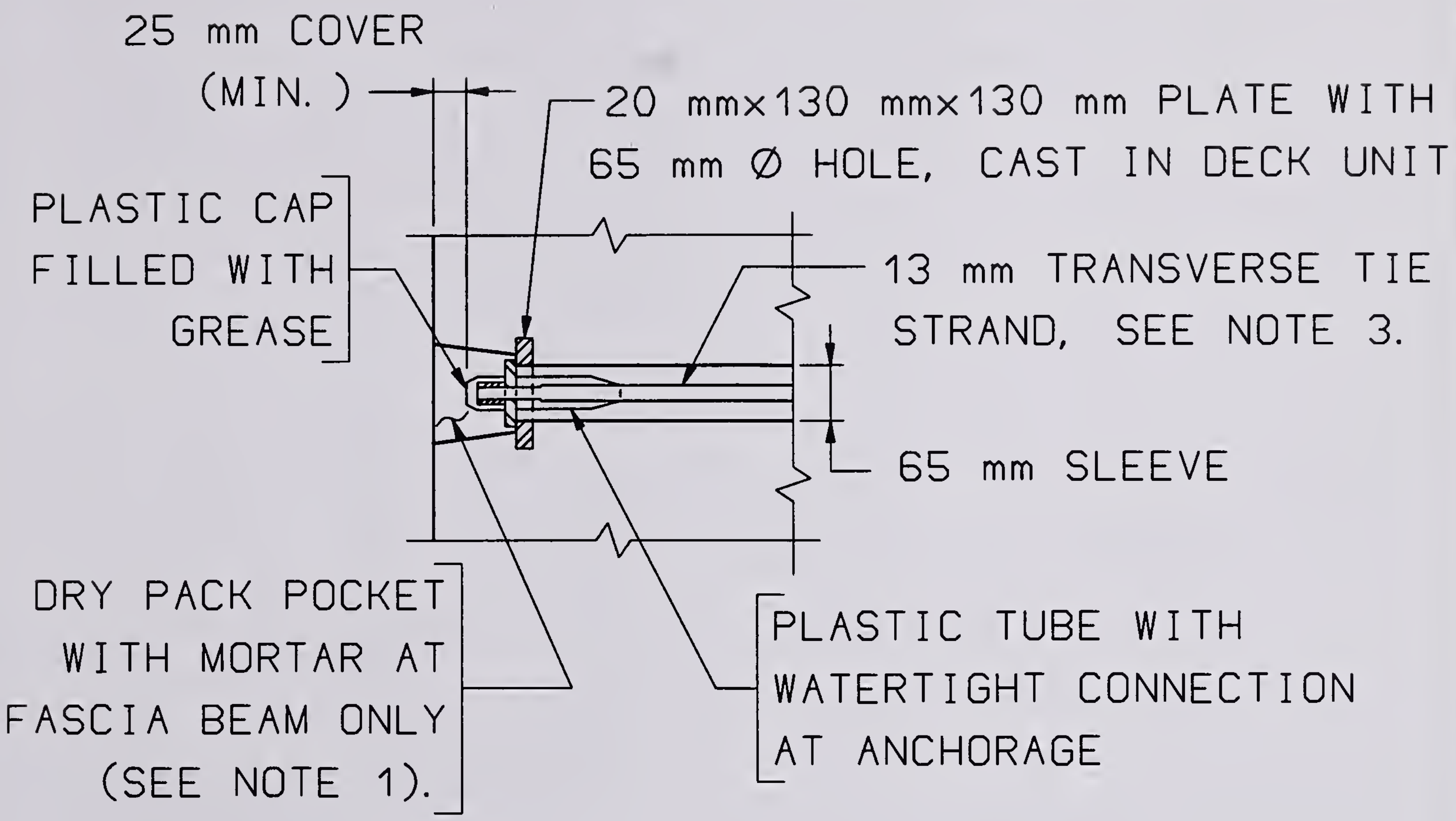
TRANSVERSE TIE TENSIONING NOTES:

1. AS EACH BEAM IS BEING ERECTED, INSTALL THE TRANSVERSE TIES WITH MULTIPOLYMER (PLASTIC) SHIMS BETWEEN THE BEAMS AT EACH TRANSVERSE TIE LOCATION (AS SHOWN IN SECTION 2).
2. TIE EACH BEAM TO THE PRECEDING BEAM BY TENSIONING EACH TRANSVERSE TIE TO 135 kN BEFORE ERECTING THE NEXT BEAM.
3. FILL ALL KEYWAYS WITH MORTAR (M4. 04. 0) AFTER TRANSVERSE TIES HAVE BEEN TENSIONED. IF THE KEYWAYS ARE NOT FILLED WITHIN FIVE DAYS AFTER THE BEAMS ARE ERECTED, THE CONTRACTOR SHALL COVER AND PROTECT THE KEYWAYS FROM THE WEATHER AND DEBRIS UNTIL THEY ARE FILLED. NO TRAFFIC OR HEAVY EQUIPMENT WILL BE PERMITTED ON THE BEAMS UNTIL ALL KEYWAYS HAVE BEEN FILLED AND THE MORTAR HAS CURED.
4. CONCRETE FOR SIDEWALK, CURB AND/OR BARRIER SECTIONS SHALL BE PLACED AFTER THE MORTAR HAS CURED.

NOTES:

1. *Adjust the above notes as necessary to conform to stage construction.*
2. *See Dwg. No. 4.1.20 for skews ≤ 30°.*

MASS HIGHWAY BRIDGE MANUAL	TRANSVERSE TIE TENSIONING NOTES, SKEWS > 30° PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.1.22**


25 mm COVER (MIN.)
20 mm×130 mm×130 mm PLATE WITH 65 mm Ø HOLE, CAST IN DECK UNIT
PLASTIC CAP FILLED WITH GREASE
13 mm TRANSVERSE TIE STRAND, SEE NOTE 3.
65 mm SLEEVE
DRY PACK POCKET WITH MORTAR AT FASCIA BEAM ONLY (SEE NOTE 1).
PLASTIC TUBE WITH WATERTIGHT CONNECTION AT ANCHORAGE

NOTES:

1. MORTAR FOR EXTERIOR POCKETS SHALL CONFORM TO M4.02.15 AND SHALL BE THE SAME COLOR AND TEXTURE AS THE BEAM CONCRETE.
2. OTHER ANCHORAGE SYSTEMS MAY BE SUBSTITUTED WITH THE APPROVAL OF THE ENGINEER. ALTERNATE ANCHORAGE SYSTEMS SHALL BE WATERTIGHT AND CORROSION PROOF.
3. TRANSVERSE TIES SHALL BE COVERED BY A SEAMLESS POLYPROPYLENE SHEATH (WITH CORROSION INHIBITING GREASE BETWEEN THE STRAND AND SHEATH) FOR THE FULL LENGTH OF THE STRAND EXCEPT AT THE ANCHORAGE LOCATION.

TRANSVERSE TIE POCKET DETAIL

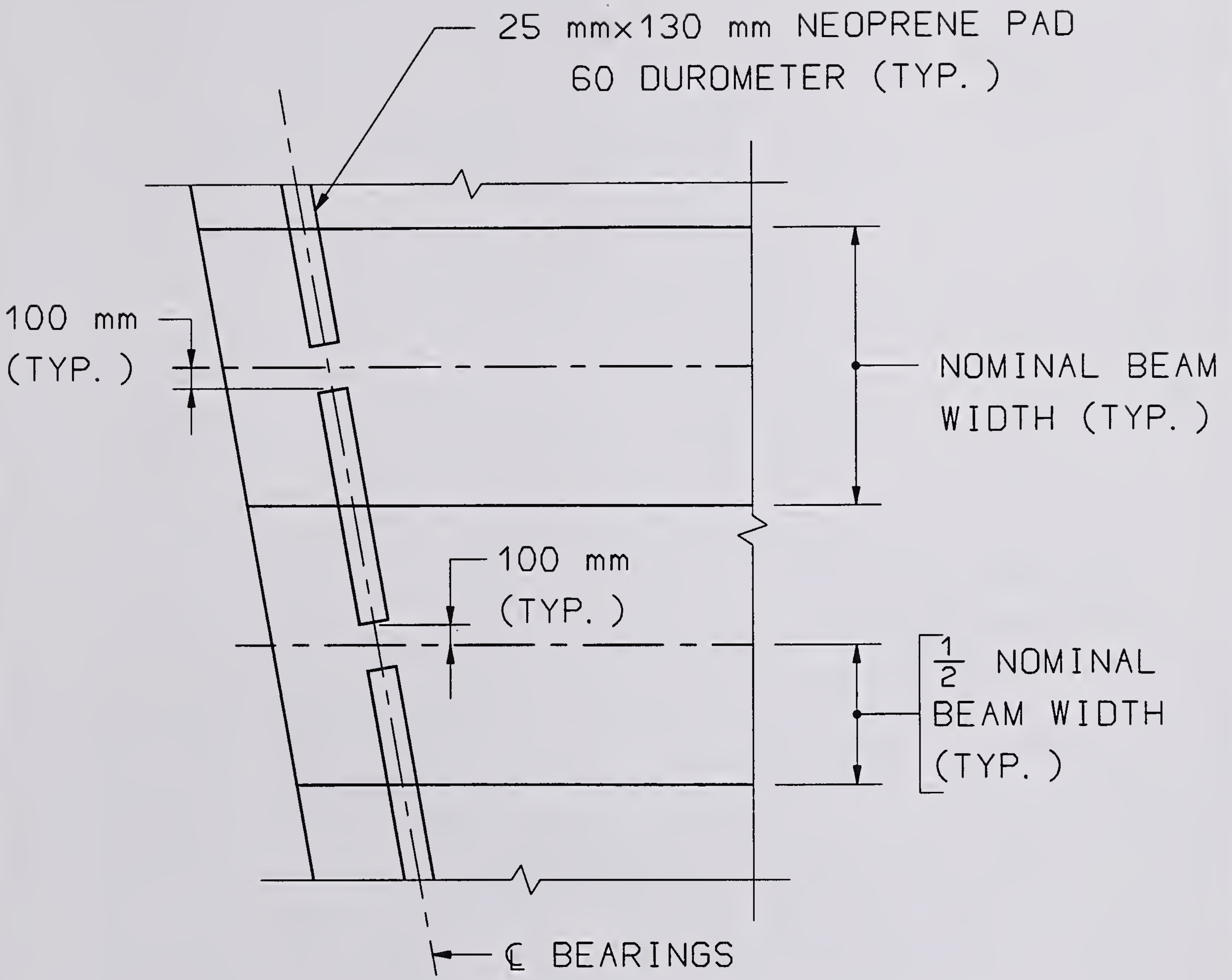
SCALE 1:10

MASS HIGHWAY
BRIDGE
MANUAL

TRANSVERSE TIE ANCHORAGE
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.23



LAYOUT OF BEARINGS *(SPANS ≤ 15m)*

NOT TO SCALE

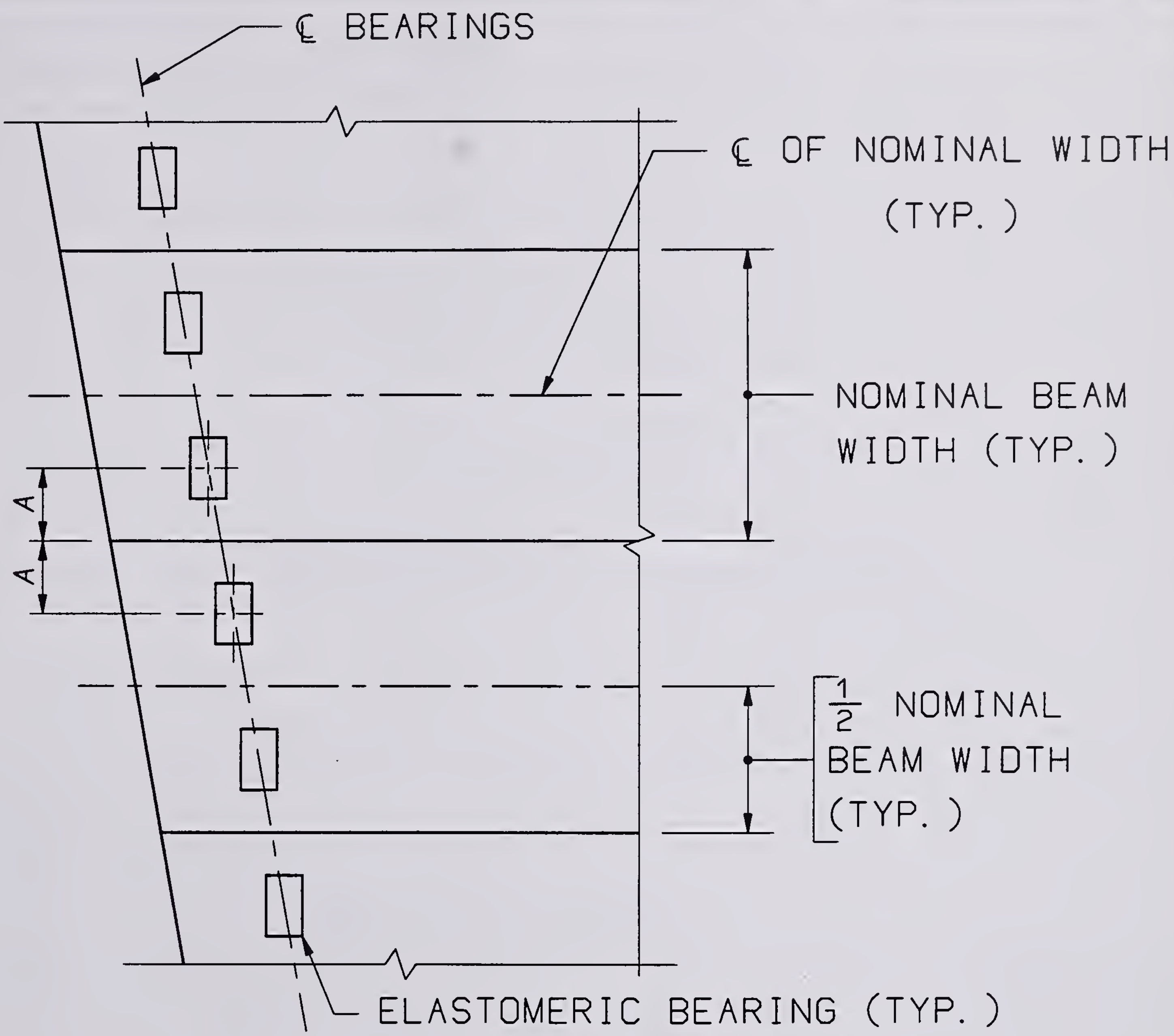
NOTE: See Dwg. No. 4.1.25 for spans greater than 15 meters..

MASSHIGHWAY
BRIDGE
MANUAL

LAYOUT OF BEARINGS
SPANS ≤ 15m
PRECAST CONCRETE DECK BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.1.24


℄ BEARINGS
℄ OF NOMINAL WIDTH (TYP.)
NOMINAL BEAM WIDTH (TYP.)
A
A
$\frac{1}{2}$ NOMINAL BEAM WIDTH (TYP.)
ELASTOMERIC BEARING (TYP.)

(Designer shall supply size and material characteristics.)

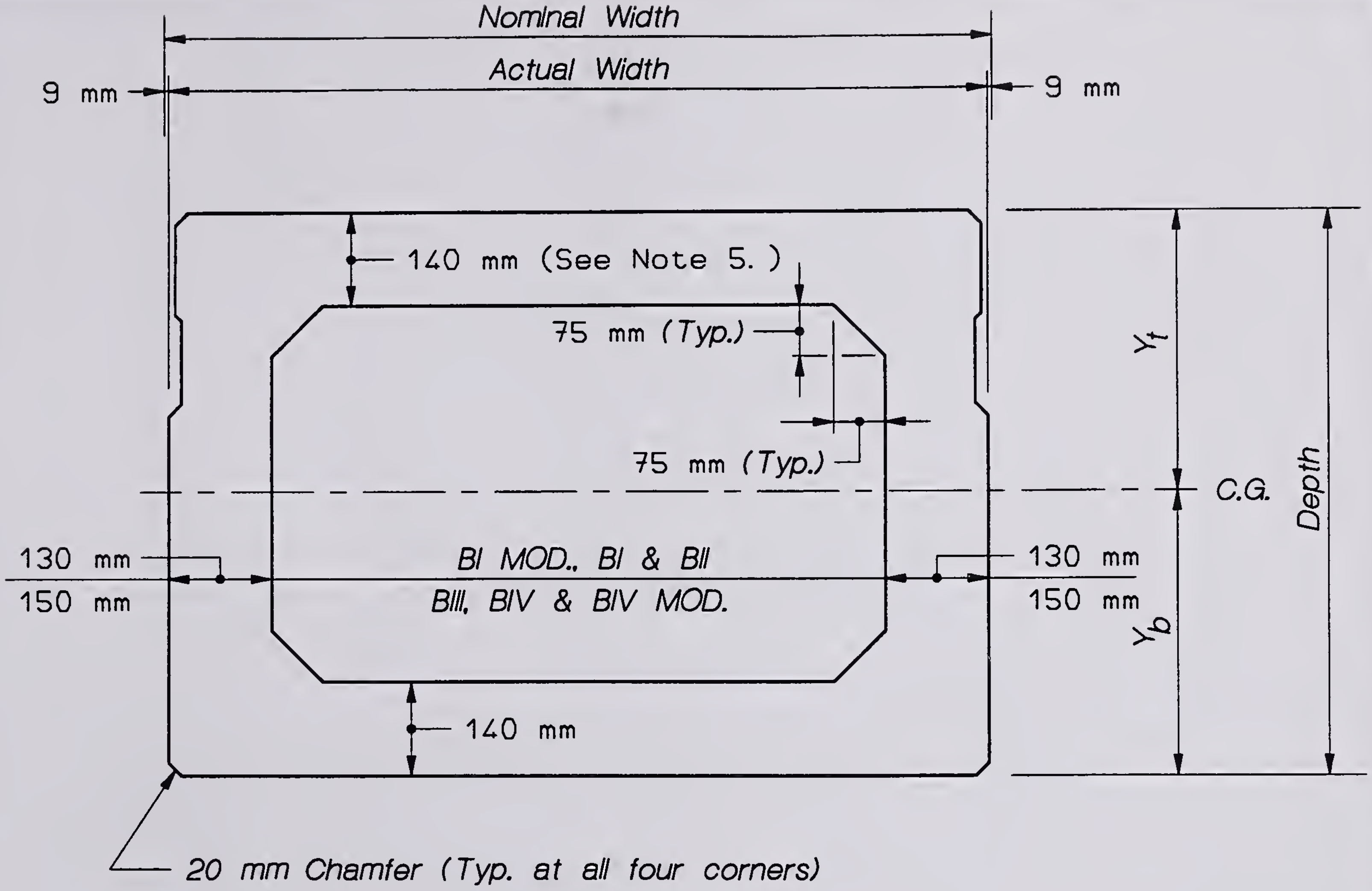
LAYOUT OF BEARINGS *(SPANS > 15m)*

NOT TO SCALE

NOTE:

1. *A = (Nominal Width of Beam) ÷ 4*
2. *See Dwg. No. 4.1.24 for spans equal to or less than 15 meters.*

MASS HIGHWAY BRIDGE MANUAL	LAYOUT OF BEARINGS SPANS > 15m PRECAST CONCRETE DECK BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.1.25**



BEAM PROPERTIES:

BEAM TYPE	WIDTH Nom. (mm)	WIDTH Act. (mm)	DEPTH (mm)	A (mm^2)	I (mm^4) x1.0E9	Y_b (mm)	Y_t (mm)	S_b (mm^3) x1.0E6	S_t (mm^3) x1.0E6	MASS (kg/m)	MAX. SPAN (m)
BI-900 MOD.	920	902	600	337710	14.419	296.720	303.280	48.595	47.543	811	20
BI-900	920	902	700	363710	21.774	345.786	354.214	62.969	61.471	874	23
BII-900	920	902	800	389710	30.947	394.977	405.023	78.351	76.408	936	26
BIII-900	920	902	1000	470510	56.513	494.033	505.967	114.39	111.69	1131	30
BIV-900	920	902	1100	500510	72.515	543.541	556.459	133.41	130.32	1203	32
BIV-900 MOD.	920	902	1200	530510	91.019	593.105	606.895	153.46	149.98	1275	34

NOTES:

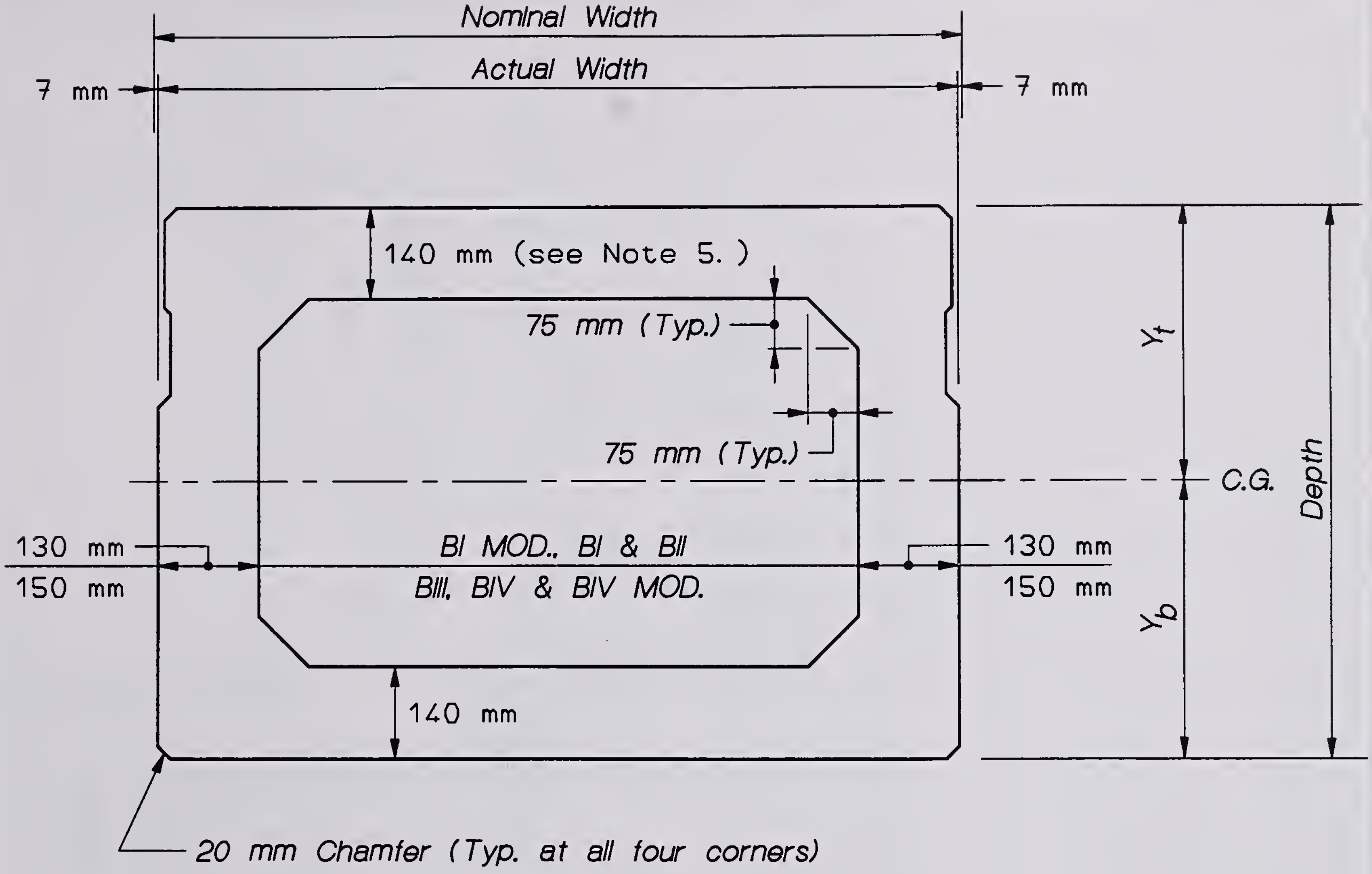
1. Above drawing is not to scale.
2. See Dwg. No. 4.2.6 for the shear key details.
3. Maximum span lengths are approximate.
4. Weight of beams do not include the weight of the solid sections located at the transverse ties. Use the total weight (including solid sections) for design.
5. Thickness of top flange may have to be increased in order to develop sidewalk/safety curb barrier reinforcement. See Dwg. No. 4.3.2. The designer will have to calculate and use the modified beam properties in such cases.

MASSHIGHWAY
BRIDGE
MANUAL

STANDARD 900 SERIES BEAMS
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.1



BEAM PROPERTIES:

BEAM TYPE	WIDTH Nom. (mm)	WIDTH Act. (mm)	DEPTH (mm)	A (mm^2)	I (mm^4) x1.0E9	Y_b (mm)	Y_t (mm)	S_b (mm^3) x1.0E6	S_t (mm^3) x1.0E6	MASS (kg/m)	MAX. SPAN (m)
BI-1200 MOD.	1220	1206	600	422830	19.061	297.380	302.620	64.096	62.986	1016	20
BI-1200	1220	1206	700	448830	28.588	346.585	353.415	82.485	80.891	1078	23
BII-1200	1220	1206	800	474830	40.357	395.877	404.123	101.94	99.863	1141	26
BIII-1200	1220	1206	1000	555630	72.394	494.947	505.053	146.27	143.34	1335	30
BIV-1200	1220	1206	1100	585630	92.269	544.48	555.52	169.46	166.10	1407	32
BIV-1200 MOD.	1220	1206	1200	615630	115.07	594.059	605.941	193.70	189.90	1479	34

NOTES:

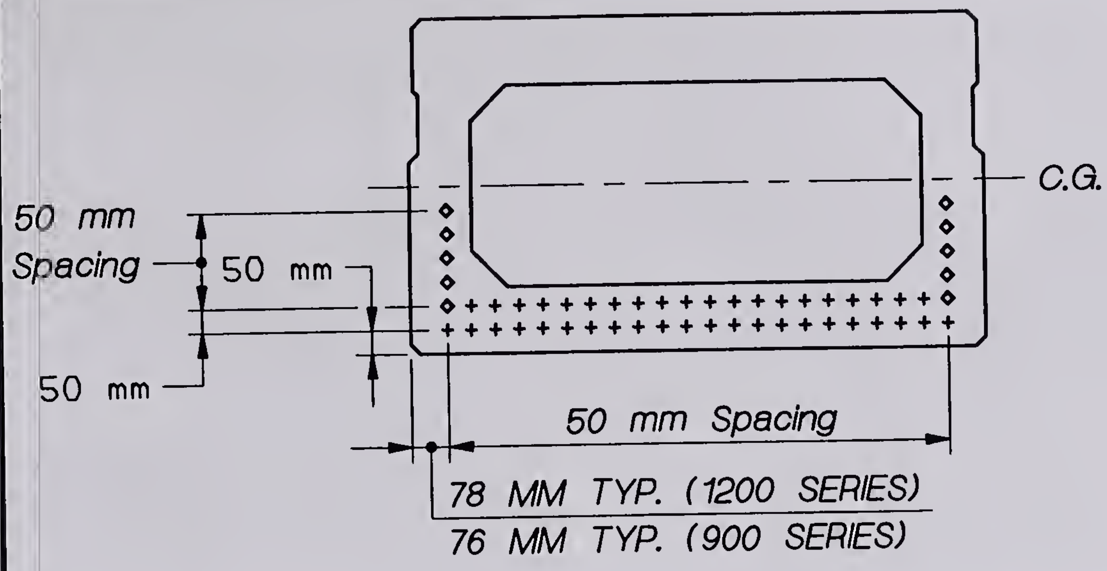
1. Above drawing is not to scale.
2. See Dwg. No. 4.2.6 for the shear key details.
3. Maximum span lengths are approximate.
4. Weight of beams do not include the weight of the solid sections located at the transverse ties. Use the total weight (including solid sections) for design.
5. Thickness of top flange may have to be increased in order to develop sidewalk/safety curb barrier reinforcement. See Dwg. No. 4.3.2. The designer will have to calculate and use the modified beam properties in such cases.

MASS HIGHWAY
BRIDGE MANUAL

STANDARD 1200 SERIES BEAMS
PRECAST CONCRETE BOX BEAMS

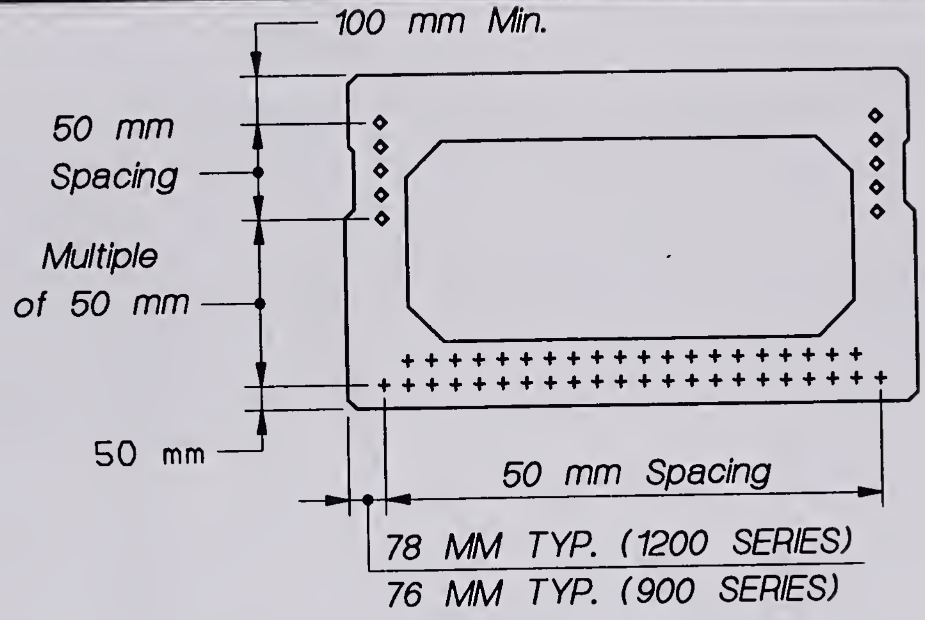
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.2



STRAND LOCATION - MIDSPAN

NOT TO SCALE

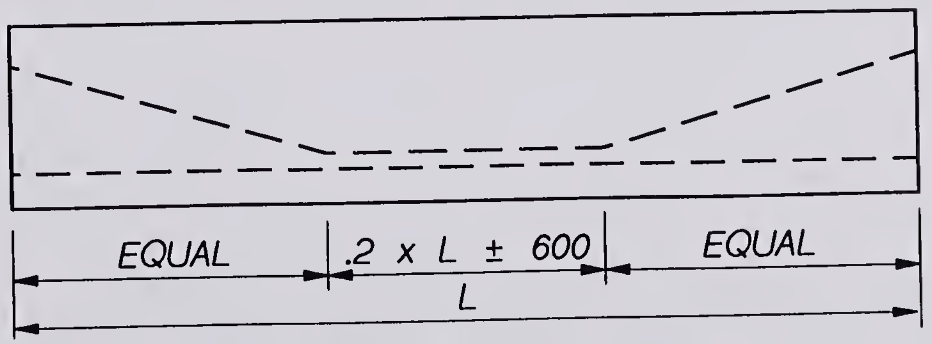


STRAND LOCATION - END OF BEAM

NOT TO SCALE

NOTES:

1. + Denotes straight strands.
2. ◇ Denotes draped strands.
3. ⊕ Denotes debonded strands (none shown above). No more than 25% of the total number of strands may be debonded. The spacing between debonded strands must be at least 100 mm apart. Do not debond the outermost strands of each layer.
4. For type BI MOD. beams, a single row of straight strands may be located 75 mm (min.) from the top of the beam in addition to and independent of the strand pattern shown above.



HOLD DOWN POINTS FOR DRAPED STRANDS

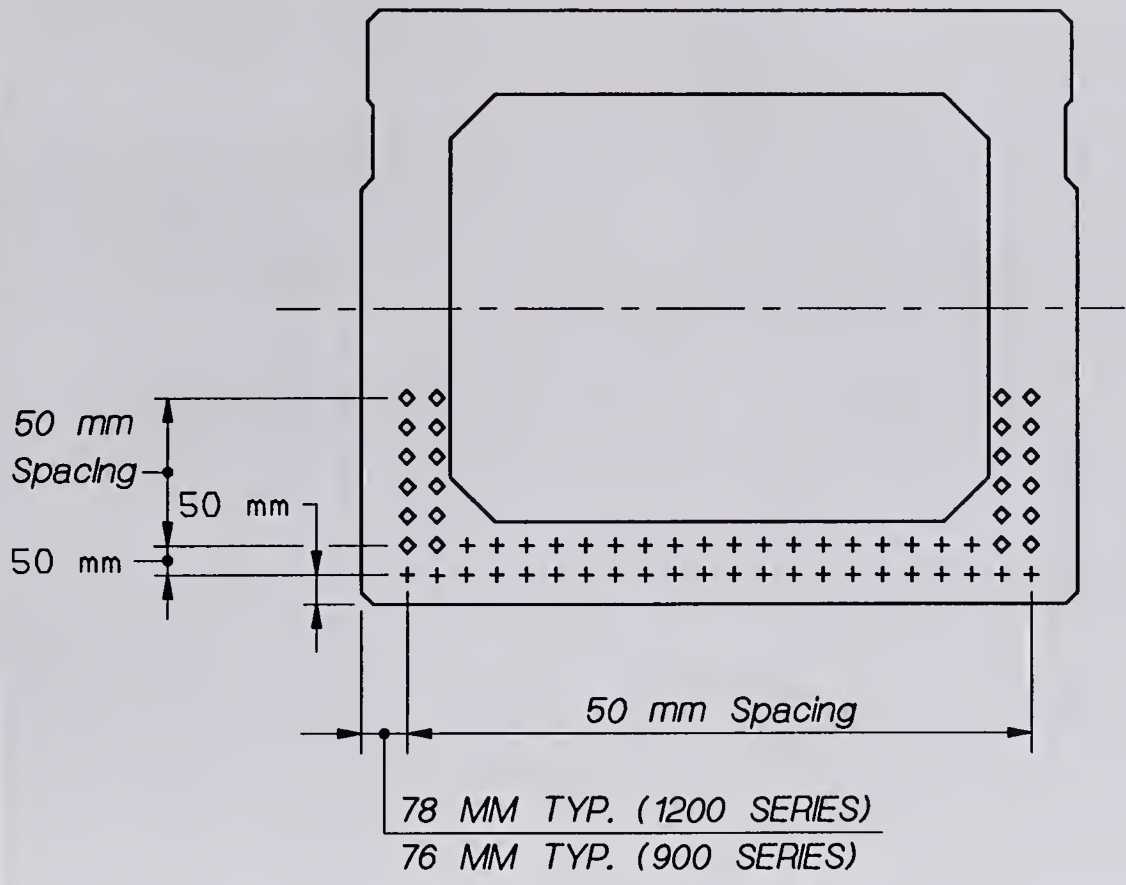
NOT TO SCALE

MASSHIGHWAY
BRIDGE
MANUAL

STANDARD STRAND LOCATION
BI, BI MOD., BII
PRECAST CONCRETE BOX BEAMS

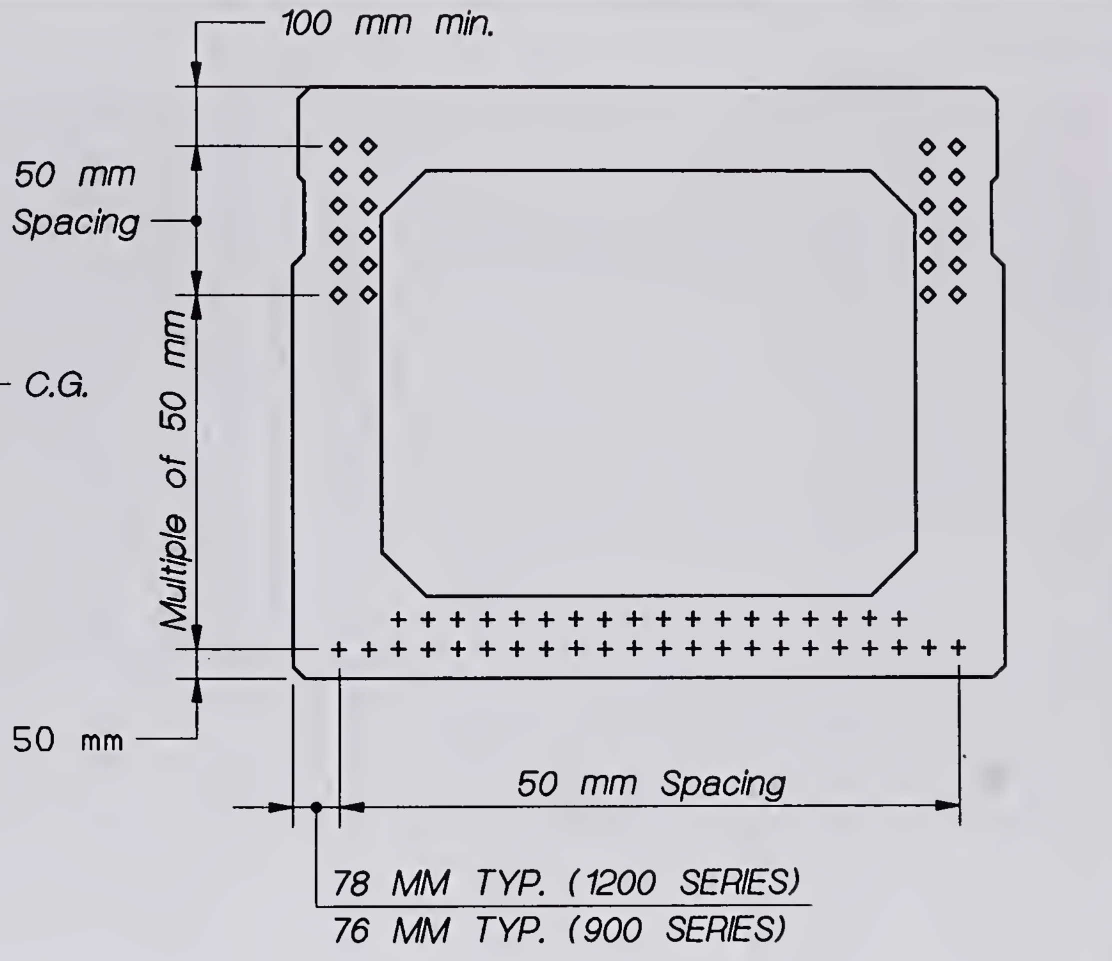
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.3



STRAND LOCATION - MIDSPAN

NOT TO SCALE



STRAND LOCATION - END OF BEAM

NOT TO SCALE

NOTES:

1. + Denotes straight strands.
2. ◇ Denotes draped strands.
3. ⊕ Denotes debonded strands (none shown above). No more than 25% of the total number of strands may be debonded. The spacing between debonded strands must be at least 100 mm apart. Do not debond the outermost strands of each layer.
4. For type BIV beams, a single row of straight strands may be located 75 mm (min.) from the top of the beam in addition to and independent of the strand pattern shown above.
5. For location of hold down points, see Drawing No. 4.2.3.

MASS HIGHWAY
BRIDGE
MANUAL

STANDARD STRAND LOCATION
BIII, BIV, BIV MOD.
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.4

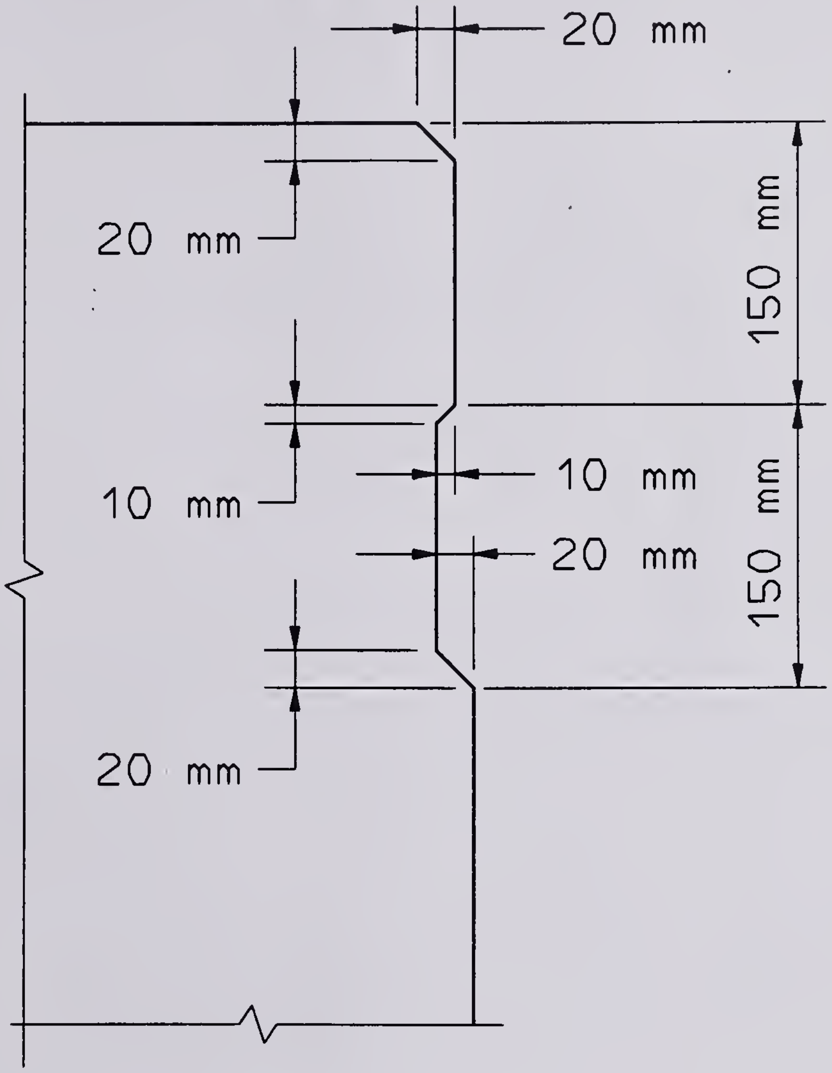
PRESTRESS NOTES:

1. ALL PRETENSIONING ELEMENTS SHALL BE 13 mm Ø, UNCOATED, SEVEN-WIRE, LOW RELAXATION STEEL STRANDS AND SHALL CONFORM TO AASHTO M203.
2. THE MINIMUM ULTIMATE TENSILE STRENGTH OF THE PRETENSIONING STRANDS SHALL BE 1860 MPa.
3. THE INITIAL TENSION PER 13 mm Ø STRAND SHALL BE XXXXX KN.
4. THE MINIMUM 28 DAY COMPRESSIVE STRENGTH SHALL BE 45 MPa. *(See Note 1 below.)*
5. NO PRESTRESS SHALL BE TRANSFERRED TO THE CONCRETE UNTIL IT HAS ATTAINED A COMPRESSIVE STRENGTH, AS SHOWN BY A CYLINDER TEST, OF AT LEAST 28 MPa. *(See Note 1 below.)*
6. THE TOP OF ALL BEAMS SHALL BE GIVEN A SMOOTH FINISH EXCEPT AS NOTED ON THE PLANS. *(See Note 2 below.)*
7. THE FABRICATOR IS FULLY RESPONSIBLE FOR THE DESIGN OF THE LIFTING DEVICES WHICH SHALL BE ADEQUATE FOR THE SAFETY FACTORS REQUIRED BY THE ERECTION PROCEDURE.

NOTES:

1. *The designer may increase the 28 day compressive strength of the concrete and/or the compressive strength at transfer if justified and feasible. See the prestressed concrete section of Part I of the Bridge Manual.*
2. *The designer shall note on the construction plans a raked finish for the tops of the prestressed beams in the areas under the sidewalks, curbs, and concrete barriers.*

MASS HIGHWAY BRIDGE MANUAL	PRESTRESS NOTES PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.2.5**



NOTE:

DEPTH OF SHEAR KEY VARIES AT TRANSVERSE TIE LOCATIONS. *(See Dwg. No. 4.2.17.)*

SHEAR KEY DETAIL

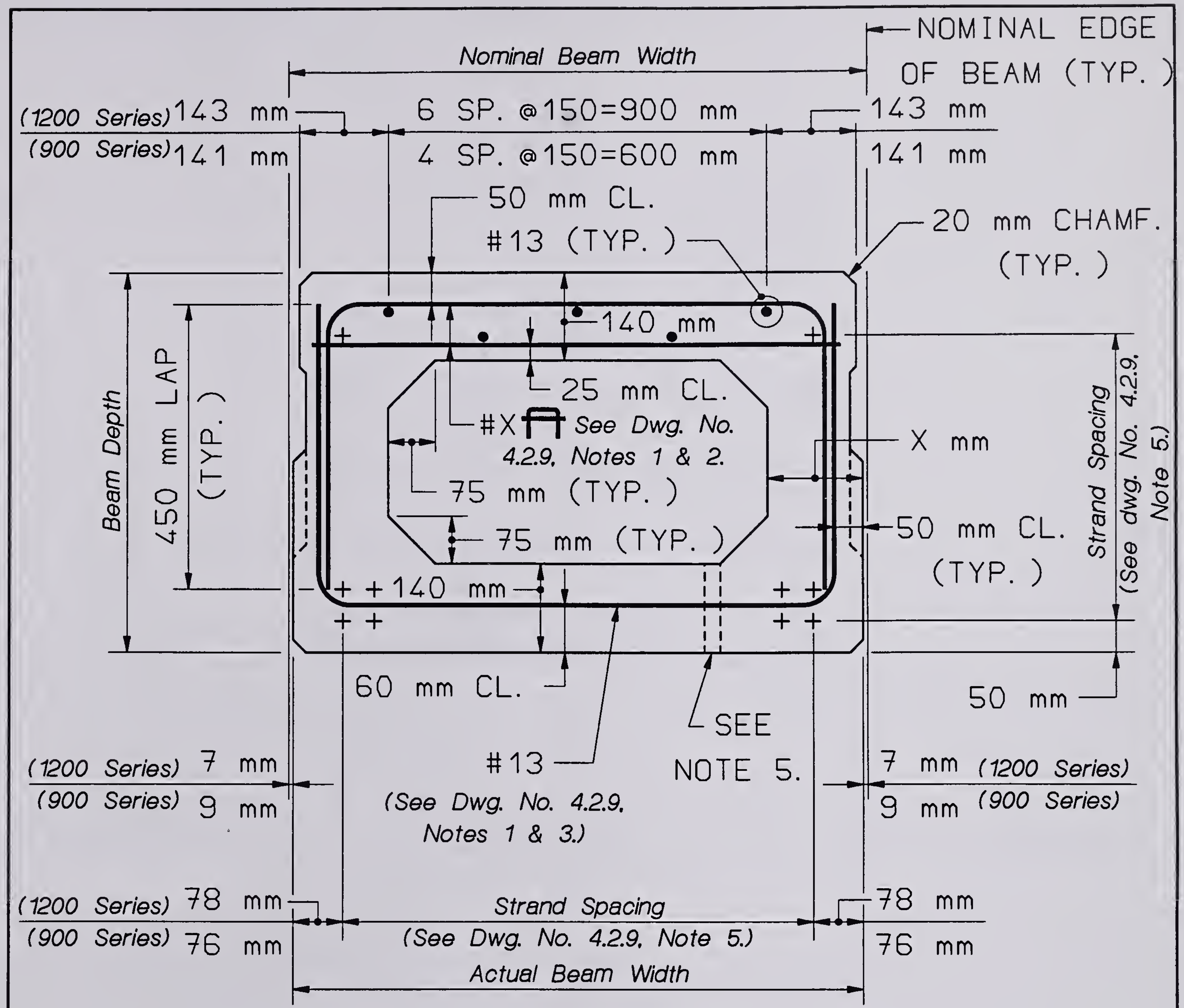
SCALE 1:5

MASS HIGHWAY
BRIDGE
MANUAL

SHEAR KEY DETAILS
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.6



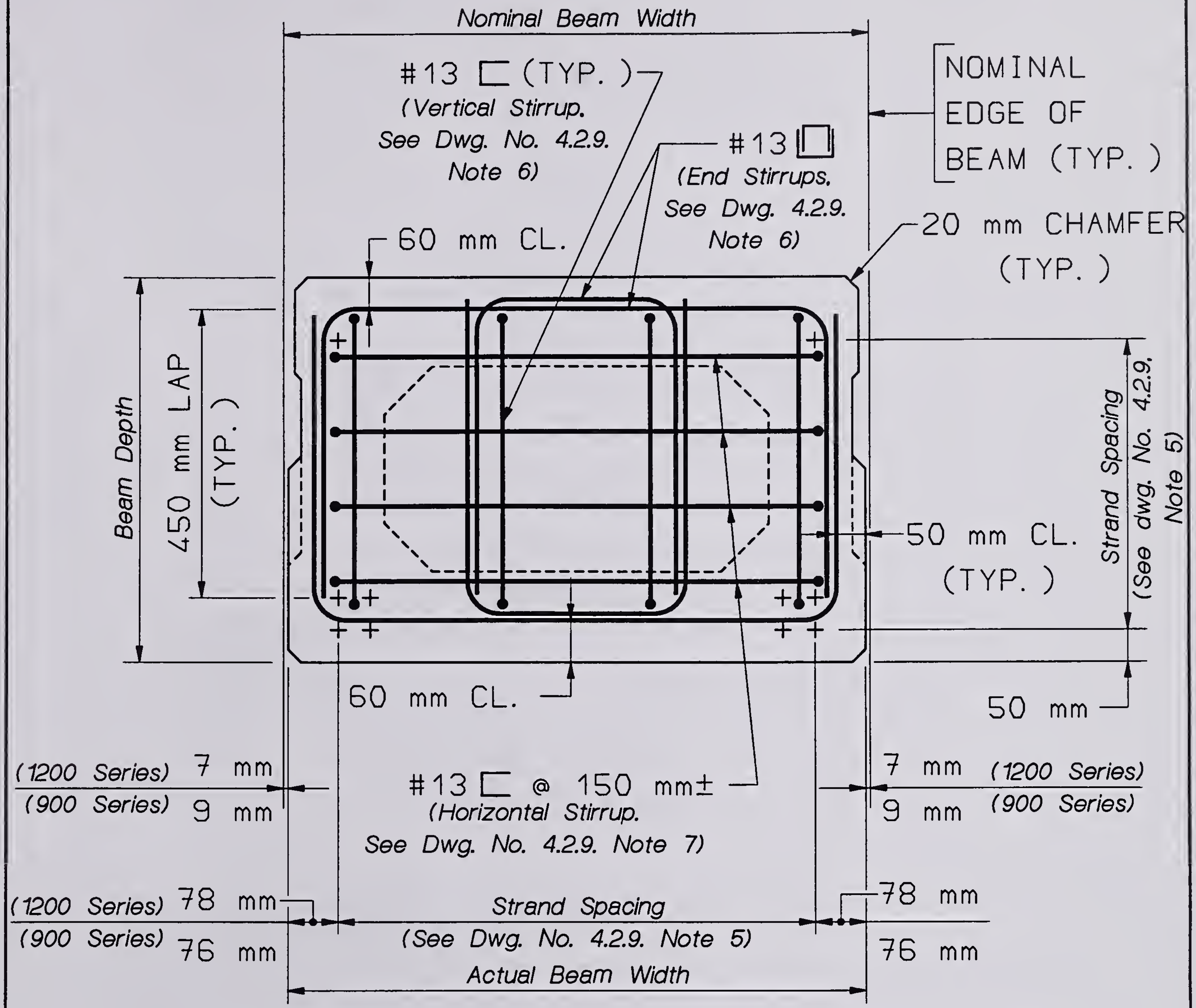
NOTES:

1. + DENOTES STRAIGHT STRANDS.
2. ◇ DENOTES DRAPED STRANDS.
3. ⊕ DENOTES DEBONDED STRANDS.
4. SEE SHEAR KEY DETAIL ON SHEET X.
5. 25 mm Ø DRAIN, PLACED AT LOW POINT OF VOIDS.
6. SEE END OF BEAM PLAN FOR STIRRUP SPACING.

MIDSPAN SECTION

SCALE 1:10

MASS HIGHWAY BRIDGE MANUAL	TYPICAL MIDSPAN SECTION PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.2.7**



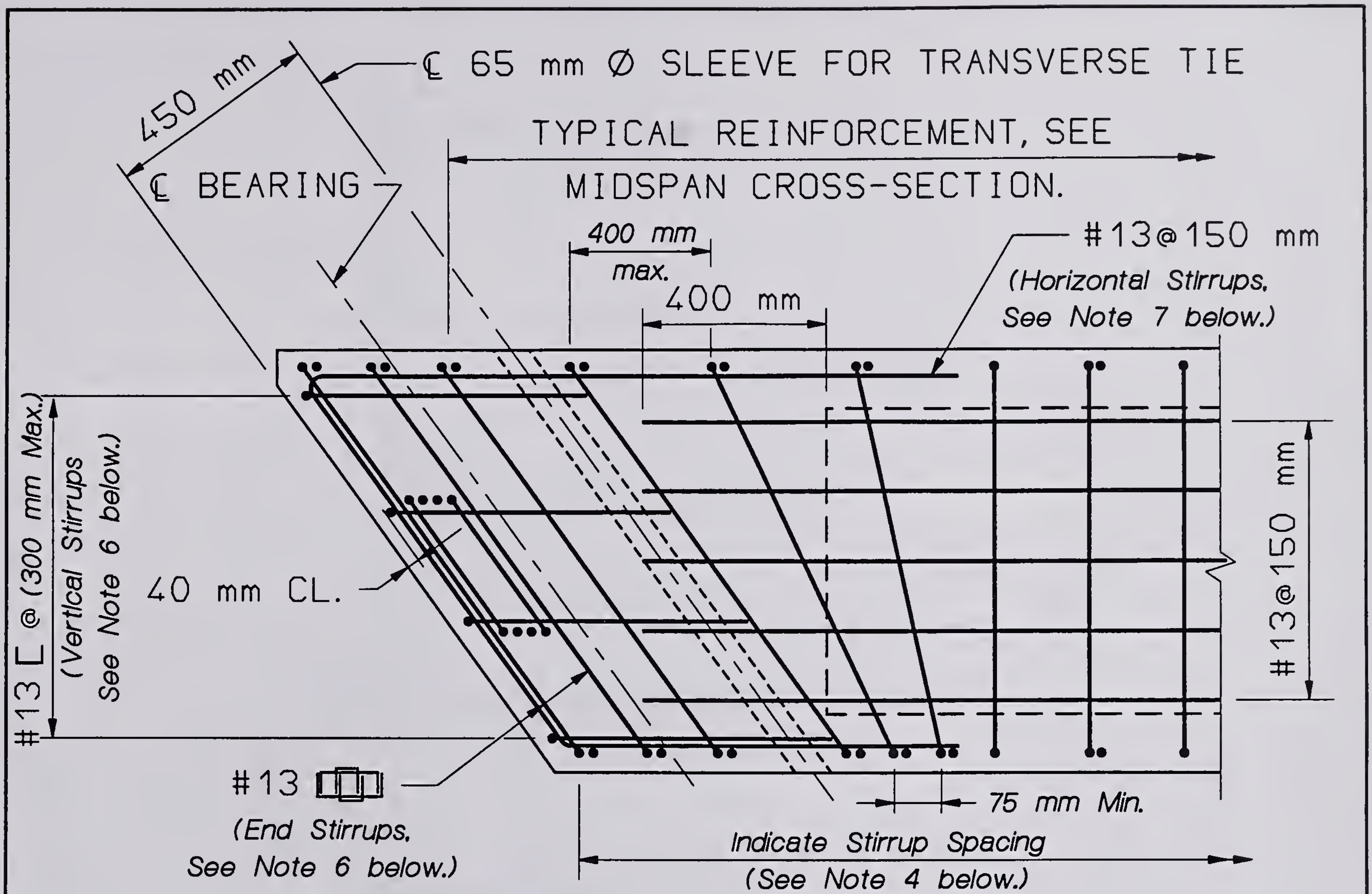
NOTES:

1. + DENOTES STRAIGHT STRANDS.
2. ◇ DENOTES DRAPED STRANDS.
3. ⊕ DENOTES DEBONDED STRANDS.
4. SEE SHEAR KEY DETAIL ON SHEET X.

END OF BEAM SECTION

SCALE 1: 10

MASS HIGHWAY BRIDGE MANUAL	TYP. END OF BEAM SECTION PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.2.8



℄ 65 mm Ø SLEEVE FOR TRANSVERSE TIE
450 mm
℄ BEARING
TYPICAL REINFORCEMENT, SEE MIDSPAN CROSS-SECTION.
400 mm max.
400 mm
#13@150 mm (Horizontal Stirrups, See Note 7 below.)
#13 ⊏ @ (300 mm Max.) (Vertical Stirrups See Note 6 below.)
40 mm CL.
#13@150 mm
#13 (End Stirrups, See Note 6 below.)
75 mm Min.
Indicate Stirrup Spacing (See Note 4 below.)

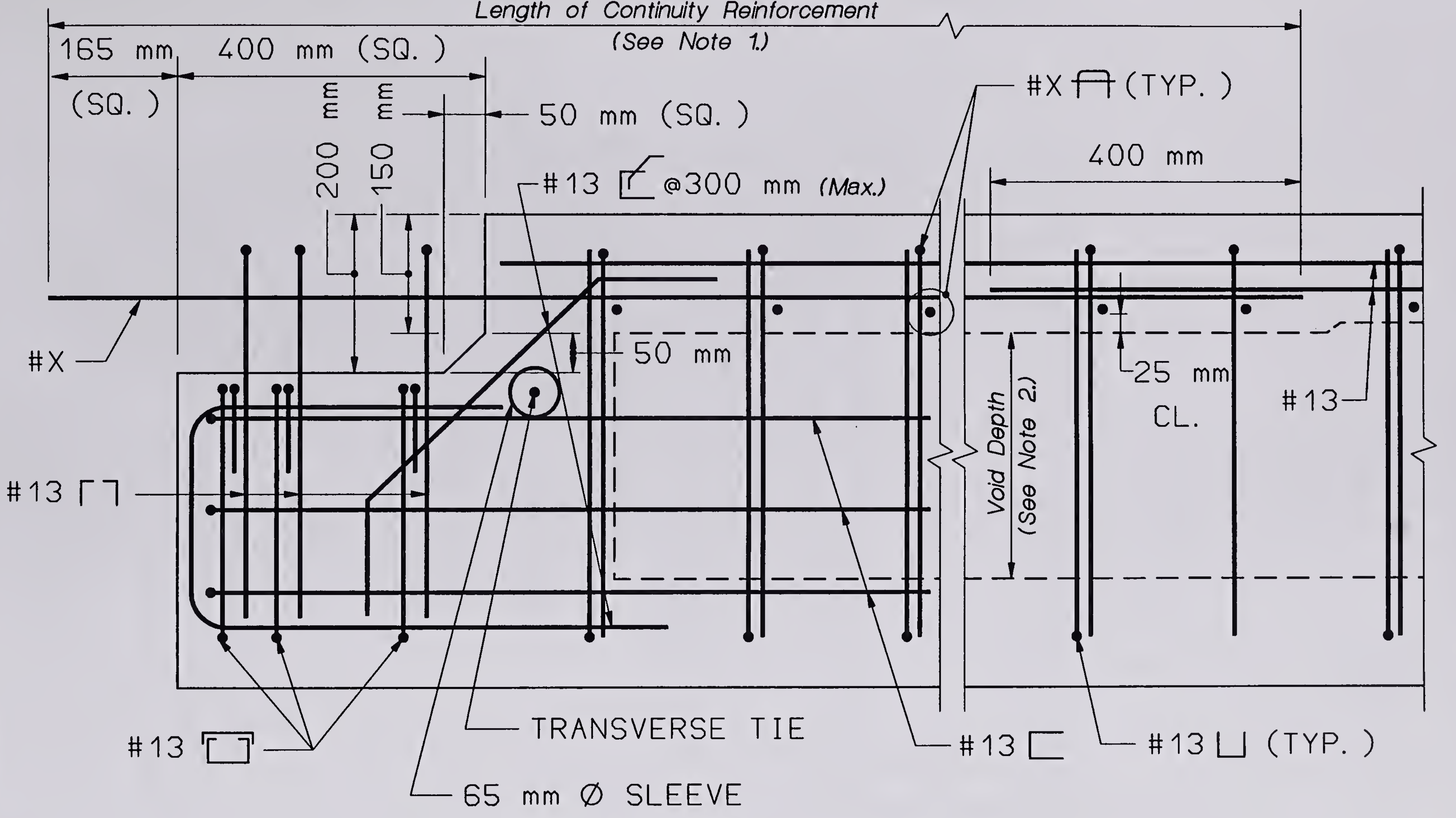
END OF BEAM PLAN

Draw to 1:20 Scale min.

NOTES:

1. *See the prestressed section of Part I of the Bridge Manual for the design of the transverse stirrups and slab reinforcement.*
2. *Use #13 or #16 bars only for the top transverse stirrups and slab reinforcement. Spacing shall not exceed 200 mm.*
3. *Bottom transverse stirrups shall be placed at a multiple of the top bar spacing with a maximum spacing of 400 mm.*
4. *The extent of the beam shown in the Plan of End of Beam should be long enough to indicate typical stirrup spacing throughout the beam.*
5. *The actual number and location of the prestressed strands shall be designed and shall conform to the spacings shown in Dwg. Nos. 4.2.3 and 4.2.4.*
6. *See the prestressed section of Part I of the Bridge Manual for the design of the end transverse stirrups and vertical stirrups. The horizontal legs of the vertical stirrups are equal to the depth of the beam and shall be dimensioned on the plan view.*
7. *Horizontal stirrups shall be embedded a minimum distance equal to the depth of the beam or 300 mm into the web of the voided section, whichever is longer. Length of embedment shall be noted on the plan view.*
8. *Properly note or show the location and spacing of any dowels which extend into sidewalks, curbs, or barriers on the cross-section and plan views of the beams.*

MASS HIGHWAY BRIDGE MANUAL	TYPICAL END OF BEAM PLAN PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.9**



LONGITUDINAL SECTION (WITH BLOCK-OUT)

Draw to 1:10 Scale min.

NOTES:

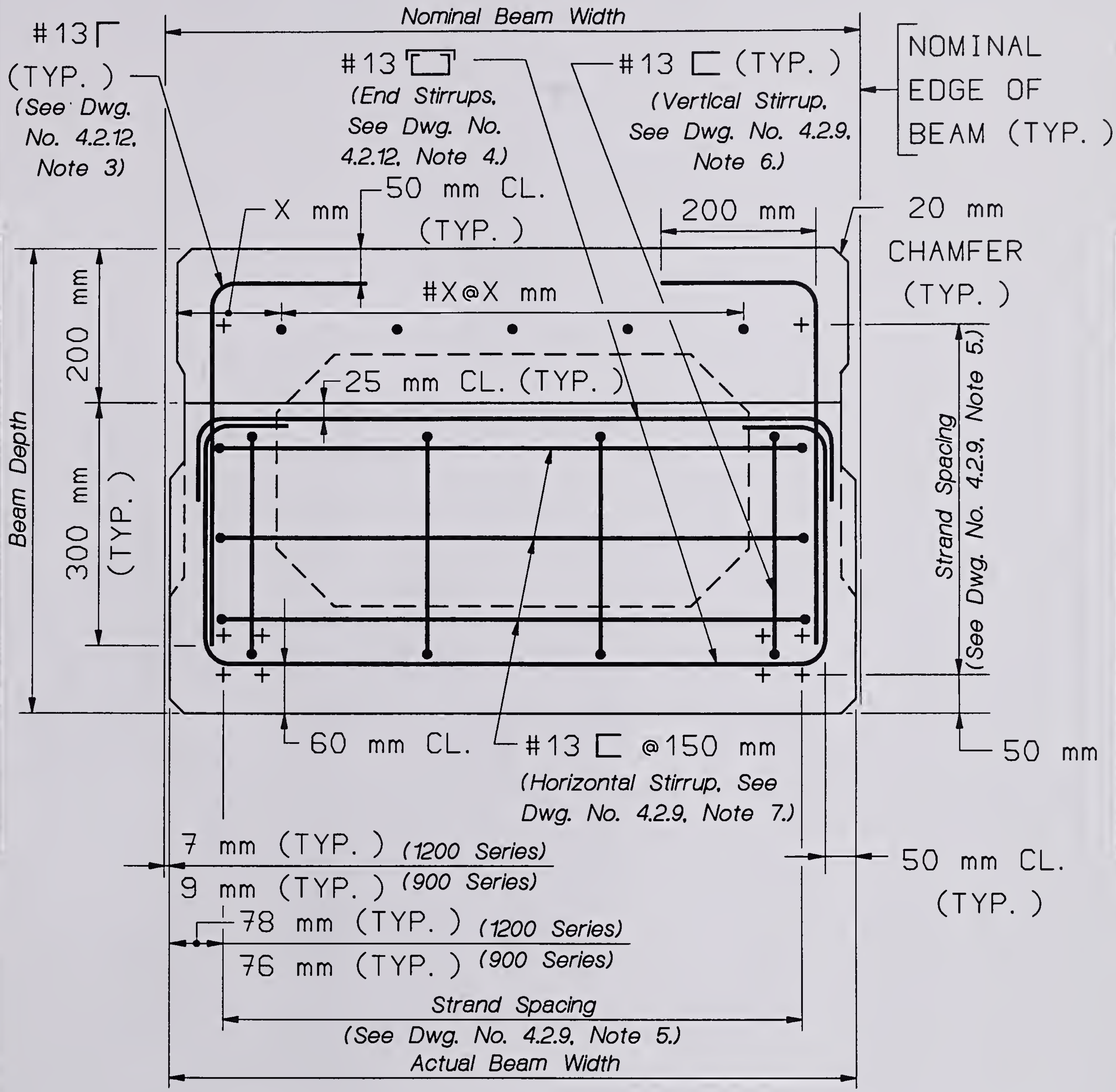
1. The length and quantity of continuity reinforcement shall be determined by the designer. See the prestressed section of Part I of the Bridge Manual for further information. Do not include continuity reinforcement if block-out is for placing a joint system.
2. The depth of the internal void may be decreased in order to maintain the required clearances between the reinforcement and the voids and/or maintain the clearances over the mechanical splice sleeve.

MASS HIGHWAY
BRIDGE
MANUAL

LONGITUDINAL SECTION
WITH BLOCK-OUT
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.10


#13 ⌐ (TYP.)
(See Dwg. No. 4.2.12, Note 3)
Nominal Beam Width
#13 (End Stirrups, See Dwg. No. 4.2.12, Note 4.)
#13 ⊏ (TYP.)
(Vertical Stirrup, See Dwg. No. 4.2.9, Note 6.)
NOMINAL EDGE OF BEAM (TYP.)
X mm
50 mm CL. (TYP.)
200 mm
20 mm CHAMFER (TYP.)
#X@X mm
25 mm CL. (TYP.)
200 mm
300 mm (TYP.)
Beam Depth
Strand Spacing (See Dwg. No. 4.2.9, Note 5.)
60 mm CL.
#13 ⊏ @150 mm
(Horizontal Stirrup, See Dwg. No. 4.2.9, Note 7.)
50 mm
7 mm (TYP.) (1200 Series)
9 mm (TYP.) (900 Series)
50 mm CL. (TYP.)
78 mm (TYP.) (1200 Series)
76 mm (TYP.) (900 Series)
Strand Spacing
(See Dwg. No. 4.2.9, Note 5.)
Actual Beam Width

NOTES:

1. + DENOTES STRAIGHT STRANDS.
2. ◇ DENOTES DRAPED STRANDS.
3. ⊕ DENOTES DEBONDED STRANDS.
4. SEE SHEAR KEY DETAIL ON SHEET X.

END OF BEAM SECTION *(WITH BLOCK-OUT)*

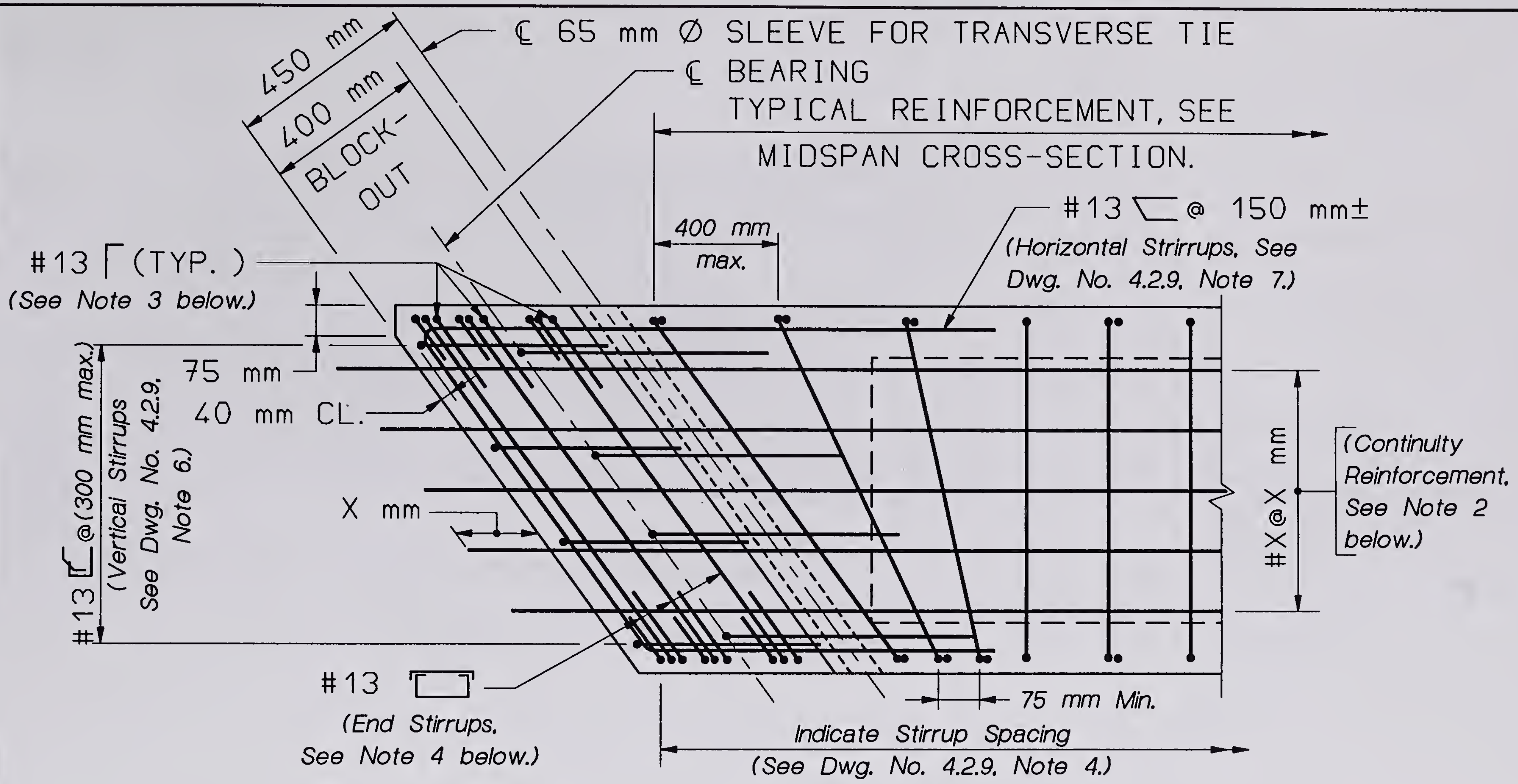
Draw to 1:10 Scale min.

MASS HIGHWAY
BRIDGE
MANUAL

END OF BEAM SECTION
W/ BLOCK-OUT
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.11


℄ 65 mm Ø SLEEVE FOR TRANSVERSE TIE
℄ BEARING
TYPICAL REINFORCEMENT, SEE MIDSPAN CROSS-SECTION.
450 mm
400 mm
BLOCK-OUT
#13 ⌈ (TYP.)
(See Note 3 below.)
400 mm max.
#13 @ 150 mm±
(Horizontal Strirrups, See Dwg. No. 4.2.9, Note 7.)
75 mm
40 mm CL.
#13 @(300 mm max.)
(Vertical Stirrups See Dwg. No. 4.2.9, Note 6.)
X mm
#X@X mm
(Continuity Reinforcement. See Note 2 below.)
#13
(End Stirrups. See Note 4 below.)
75 mm Min.
Indicate Stirrup Spacing
(See Dwg. No. 4.2.9, Note 4.)

END OF BEAM PLAN (WITH BLOCK-OUT)

Draw to 1:20 Scale min.

NOTES:

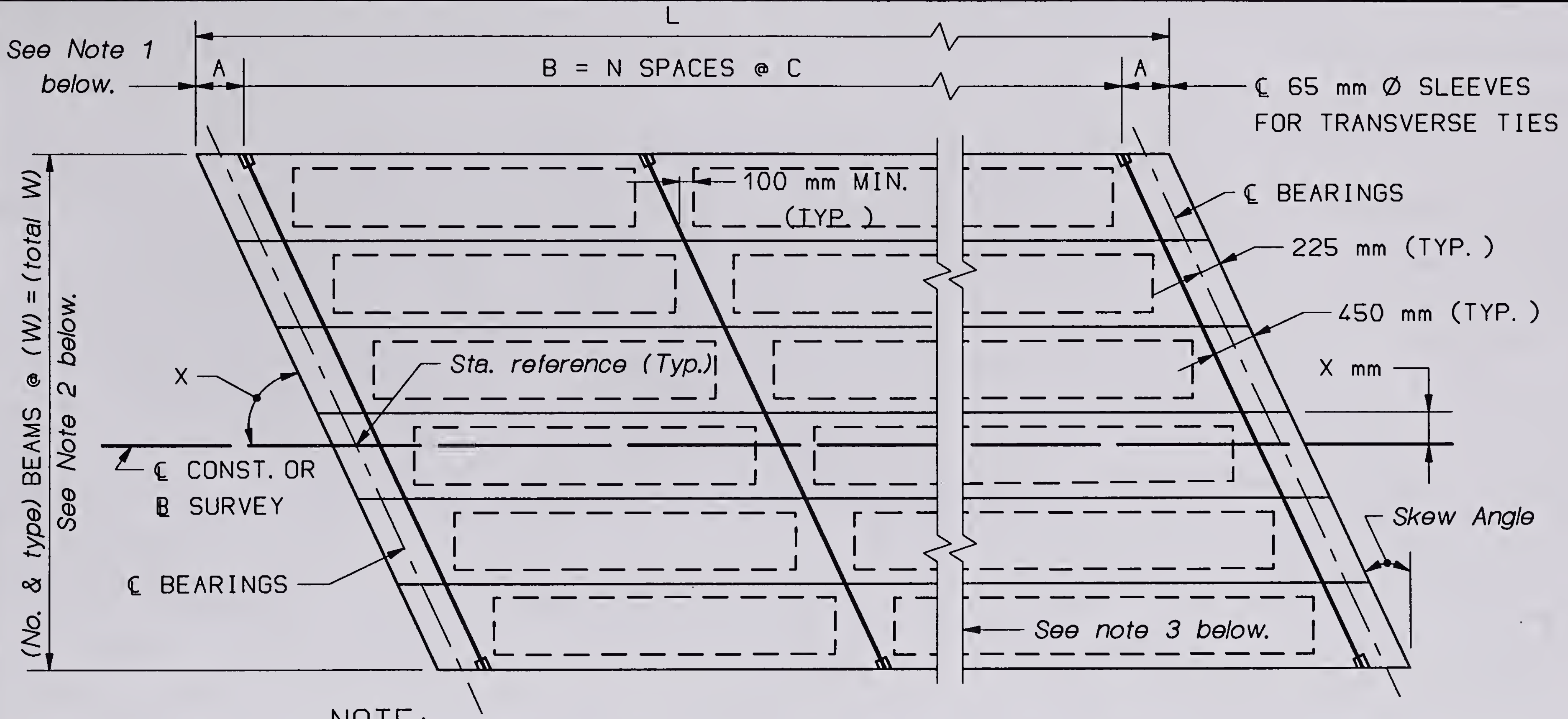
1. Block-out sections may be utilized for placing a joint system or for beam continuity. Provide a plan view for each end of the beam unless they are identical.
2. If block-out section is for a joint system, omit continuity reinforcement above and provide #13 @150 mm horizontal bars as in Dwg. No. 4.2.9.
3. If block-out section is for continuity, provide #13 ⌈ dowels to meet shear requirements. If block-out section is for a joint system, provide a minimum of 4-#13 ⌈ dowels.
4. End stirrups located 1/4 of the beam depth from the end shall be designed as indicated on Dwg. No. 4.2.9, Note 6. All other stirrups in the block-out section shall be designed as transverse stirrups, see Dwg. No. 4.2.9, Notes 1 & 3.
5. See Dwg. No. 4.2.10, Note 8.

MASSHIGHWAY
BRIDGE
MANUAL

END OF BEAM PLAN
W/ BLOCK-OUT
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.12



NOTE:
SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.

FRAMING PLAN *(SKEW ≤ 30°)*

Draw to 1:100 Scale min.

NOTES:

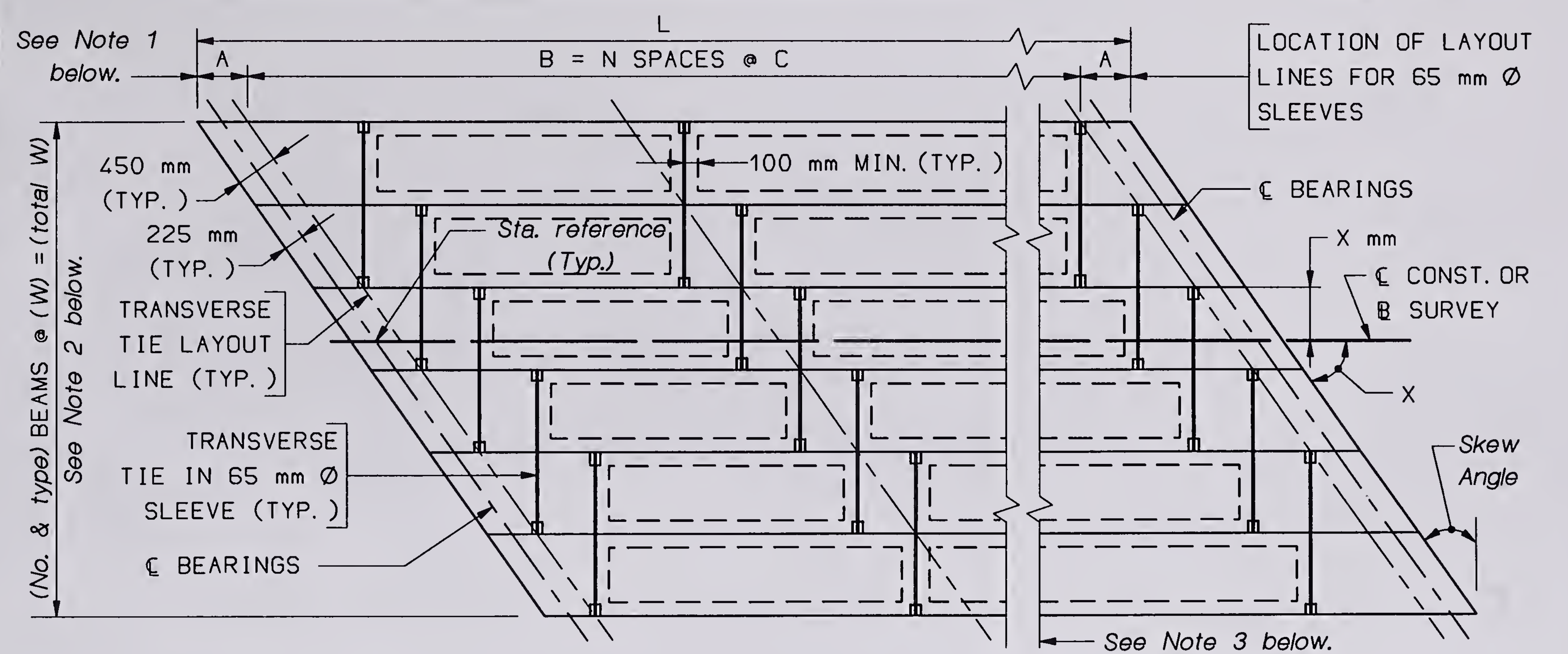
1. *A - 450 mm/COS(Skew Angle)*
   L - Span Length + A
   B - L - (2 x A)
   C - B/N where N - number of internal voids. (See Dwg. No. 4.2.16 for the required number of transverse ties.)
2. *Specifiy beam type (e.g. BI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).*
3. *Framing plan shall be drawn full length without breaks and to scale on the construction plans. Show all internal voids and transverse ties and include north arrow.*

MASSHIGHWAY
BRIDGE
MANUAL

FRAMING PLAN (SKEW ≤ 30°)
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.13



NOTE:
SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.

FRAMING PLAN (*SKEW > 30°*)

Draw to 1:100 Scale min.

NOTES:

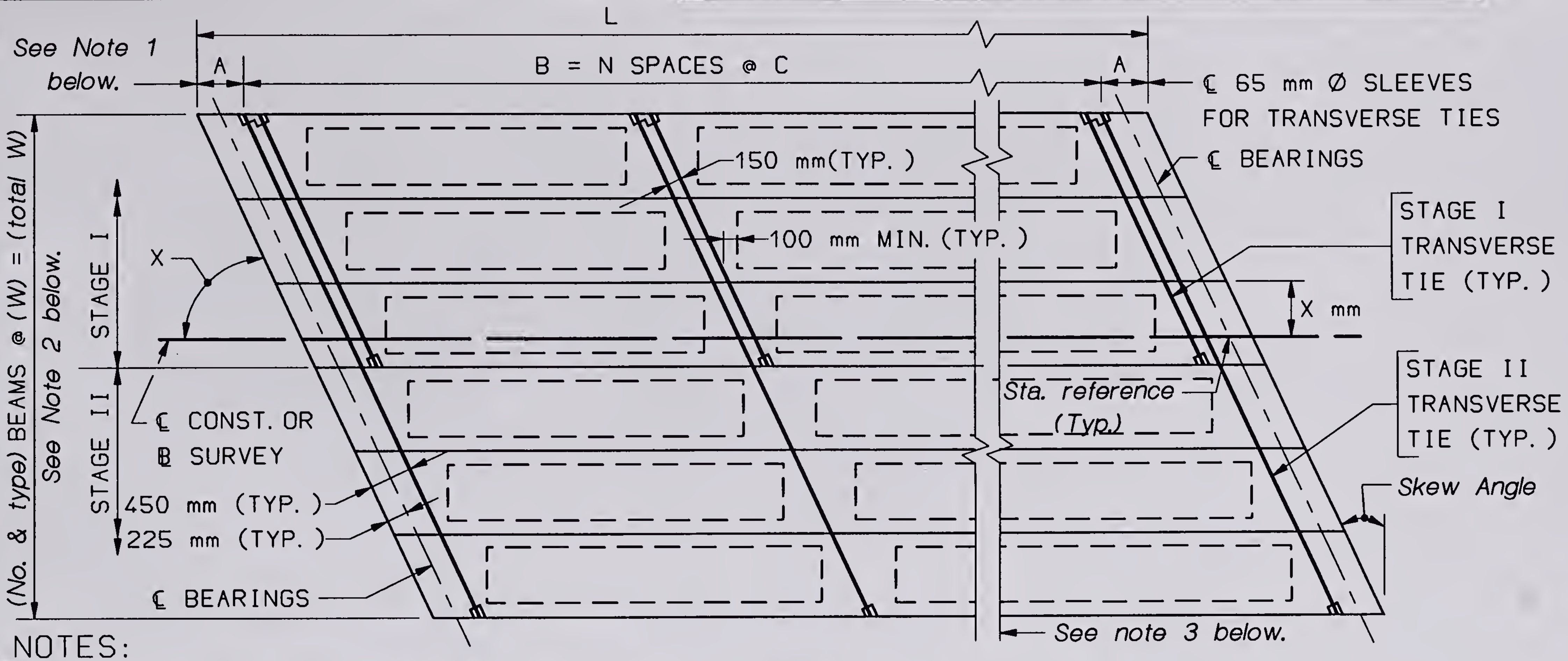
1. *A = 450 mm/COS(Skew Angle)*
   L = Span Length + A
   B = L - (2 x A)
   C = B/N where N = number of internal voids. (See Dwg. No. 4.2.16 for the required number of transverse ties.)
2. *Specify beam type (e.g. BI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).*
3. *Framing plan shall be drawn full length without breaks and to scale on the construction plans. Show all internal voids and transverse ties and include north arrow.*

MASS HIGHWAY
BRIDGE MANUAL

FRAMING PLAN (SKEW > 30°)
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.14



NOTES:

1. SEE STANDARD SPECIFICATIONS FOR BEAM ERECTION AND LAYOUT.
2. STAGE I: AFTER ERECTING STAGE I BEAMS, INSTALL AND TENSION TRANSVERSE TIES IN STAGE I SLEEVES.
3. STAGE II: AFTER ERECTING STAGE II BEAMS, INSTALL AND TENSION TRANSVERSE TIES IN STAGE II SLEEVES FULL WIDTH OF BRIDGE.

FRAMING PLAN *(STAGE CONSTRUCTION, SKEW ≤ 30°)*

Draw to 1:100 Scale min.

NOTES:

1. *A - 450 mm/COS(Skew Angle)*
   L - Span Length + A
   B - L - (2 x A)
   C - B/N where n - number of internal voids. (See Dwg. No. 4.2.16 for the required number of transverse ties.)
2. *Specify beam type (e.g. BI-1200). Use only nominal beam widths when specifing beam width (W) and calculating total width (total W).*
3. *Framing plan shall be drawn full length without breaks and to scale on construction plans. Show all internal voids and include north arrow.*

MASS HIGHWAY
BRIDGE
MANUAL

FRAMING PLAN
STAGE CONSTRUCTION
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.15

TRANSVERSE TIE LOCATIONS:

BEAM TYPE	SPAN LENGTH	TIE LOCATIONS				TOP STRAND	BOTTOM STRAND
		Ends	$\frac{1}{4}$ Points	$\frac{1}{3}$ Points	Midspan		
BI & BI MOD.	<15 m	X			X	X	
	>15 m	X		X		X	
BII	≤22.8 m	X		X		X	
	>22.8 m	X	X		X	X	
BIII	≤22.8 m	X		X		X	X
	>22.8 m	X	X		X	X	X
BIV & BIV MOD.	ALL	X	X		X	X	X

NOTE:

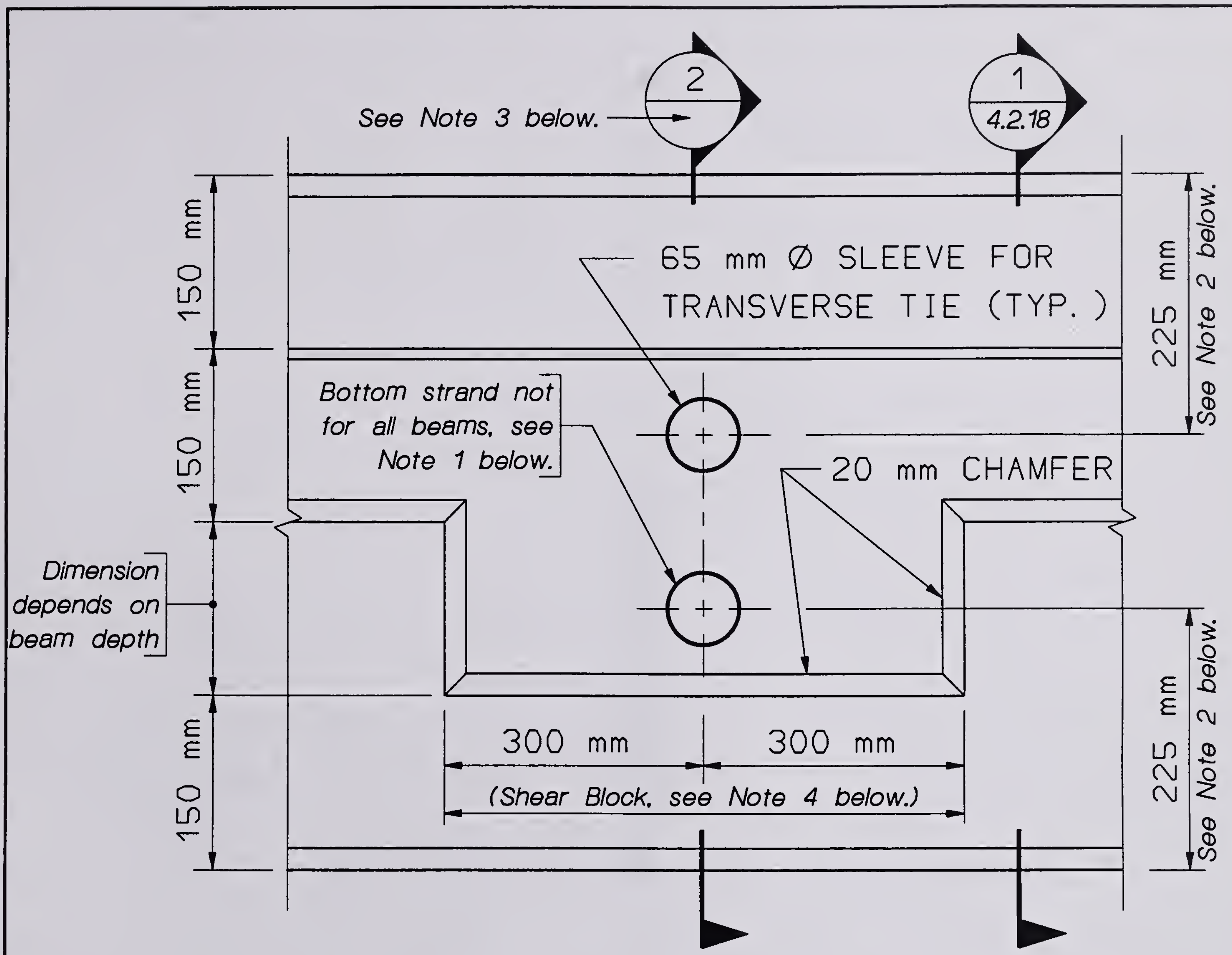
If the torsional load in the fascia beams (due to sidewalk overhang or utilities) is excessive, consideration will be given to increasing the number of transverse ties and/or the post-tensioning force. Adjust the transverse tie locations as necessary.

MASS HIGHWAY
BRIDGE
MANUAL

TRANSVERSE TIE LOCATIONS
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.16


2
1
4.2.18
See Note 3 below.
65 mm Ø SLEEVE FOR TRANSVERSE TIE (TYP.)
Bottom strand not for all beams, see Note 1 below.
20 mm CHAMFER
150 mm
150 mm
Dimension depends on beam depth
150 mm
225 mm
See Note 2 below.
225 mm
See Note 2 below.
300 mm
300 mm
(Shear Block, see Note 4 below.)

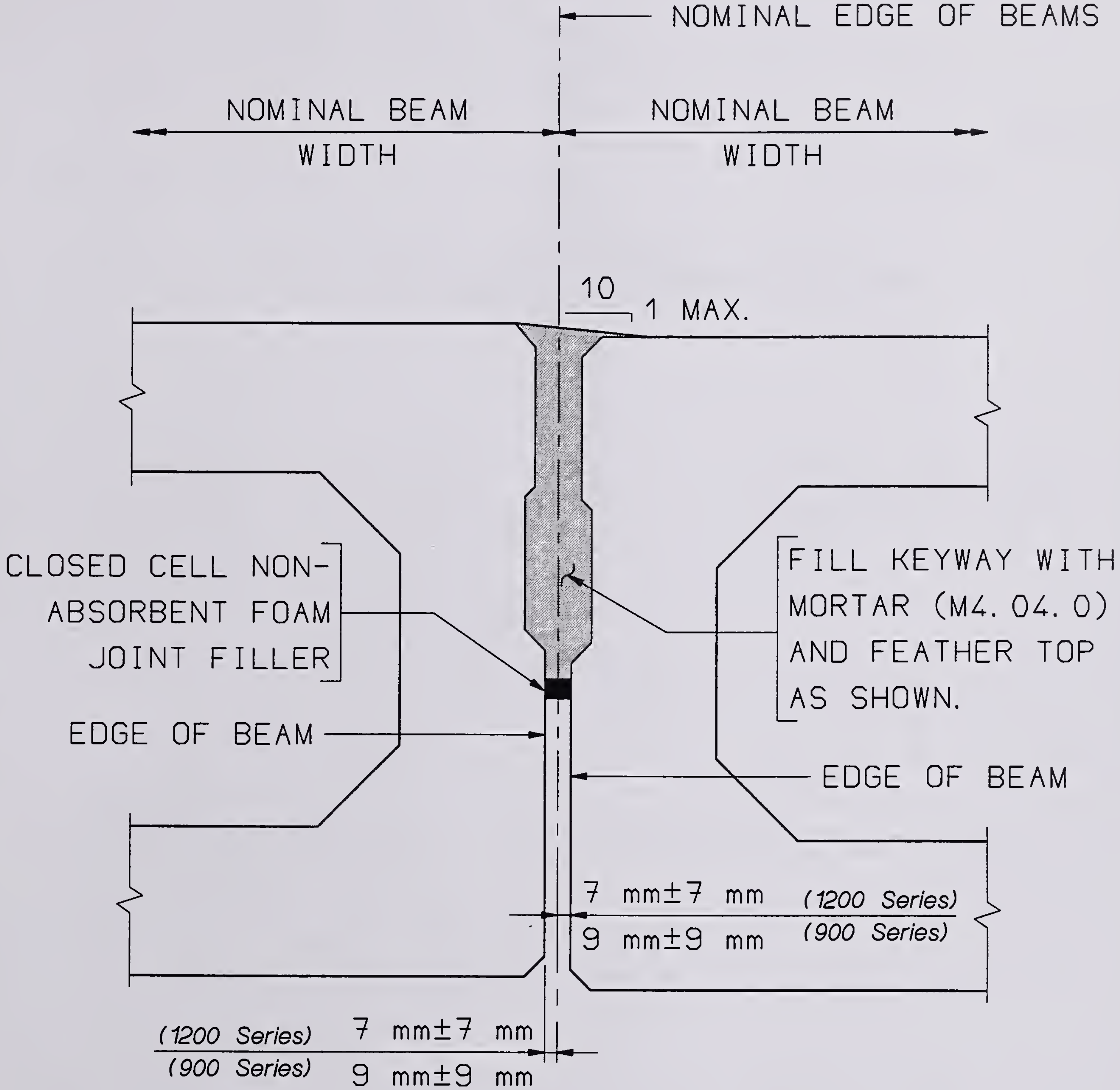
TYPICAL BEAM ELEVATION AT TRANSVERSE TIE LOCATIONS

NOT TO SCALE

NOTES:

1. *See Dwg. No. 4.2.16 for the locations of the transverse ties and for the bottom strand requirements.*
2. *The vertical position of the transverse tie strands must be coordinated with the locations of the prestressed strands and adjusted as necessary.*
3. *See Dwg. No. 4.2.19 for skews less than or equal to 30°. See Dwg. No. 4.2.21 for skews greater than 30°.*
4. *When two horizontal sets of ties are used for stage construction, increase the width of the shear block by the longitudinal skew spacing of the sleeves. Maintain 300 mm clearance from the center of each sleeve to the edge of the shear block.*

MASS HIGHWAY BRIDGE MANUAL	LONGITUDINAL JOINT ELEVATION PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.17**



SECTION 1

NOT TO SCALE

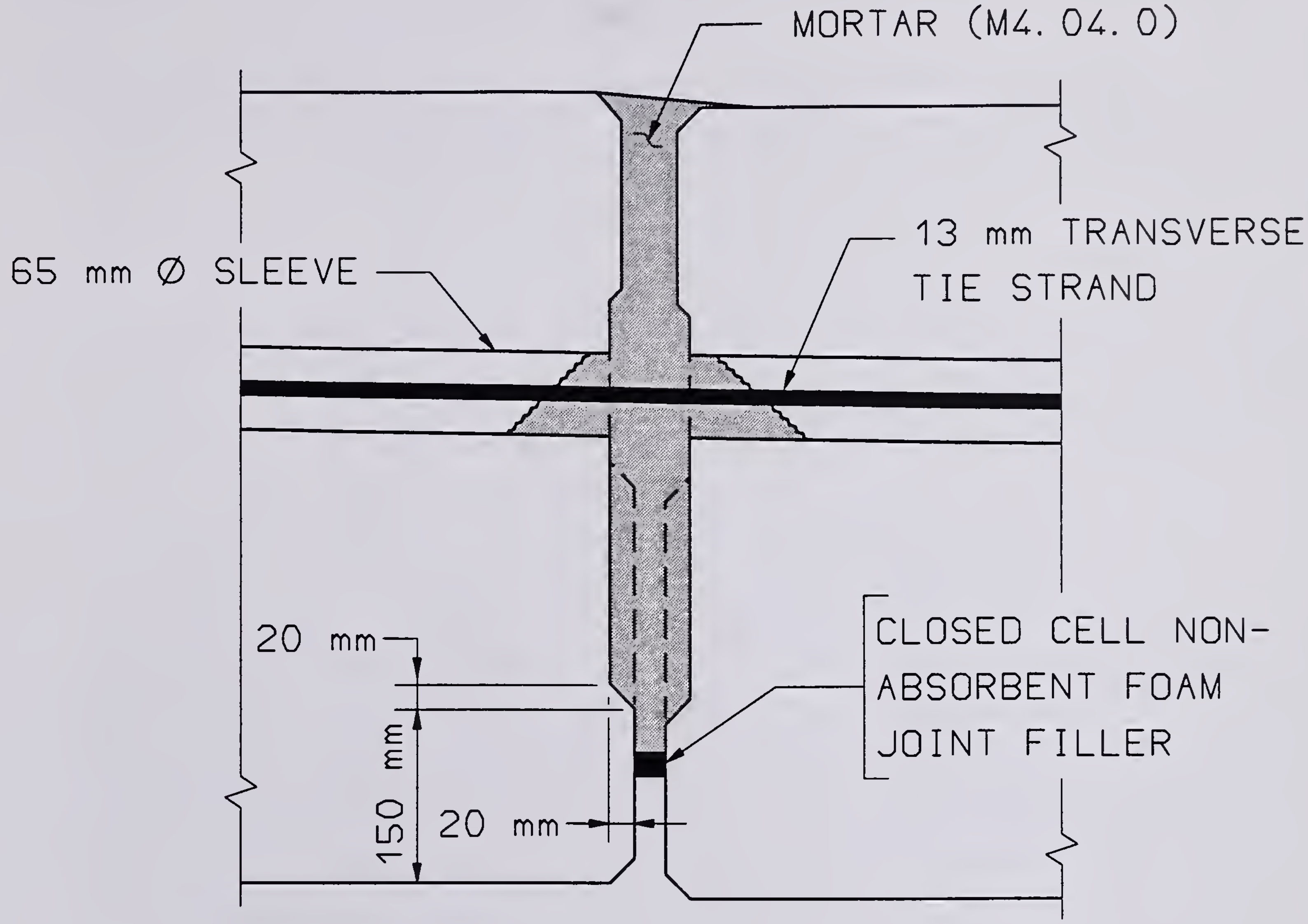
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL LONGITUDINAL JOINT SECTION

PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.18


MORTAR (M4. 04. 0)
65 mm Ø SLEEVE
13 mm TRANSVERSE TIE STRAND
20 mm
150 mm
20 mm
CLOSED CELL NON-ABSORBENT FOAM JOINT FILLER

NOTES:

1. SEE SECTION 1 FOR JOINT DETAILS NOT SHOWN HERE.
2. SEE TRANSVERSE TIE TENSIONING NOTES FOR TENSIONING PROCEDURE.

SECTION 2 *(SKEW ≤ 30°)*

NOT TO SCALE

NOTES:

1. *See Dwg. No. 4.2.21 for skews greater than 30°.*
2. *Add bottom transverse strand to this drawing for Type BIII, BIV and BIV Mod. beams.*

MASS HIGHWAY BRIDGE MANUAL	TRANSVERSE TIE DETAIL SKEW ≤ 30° PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.19**

FOR SKEWS ≤ 30° :

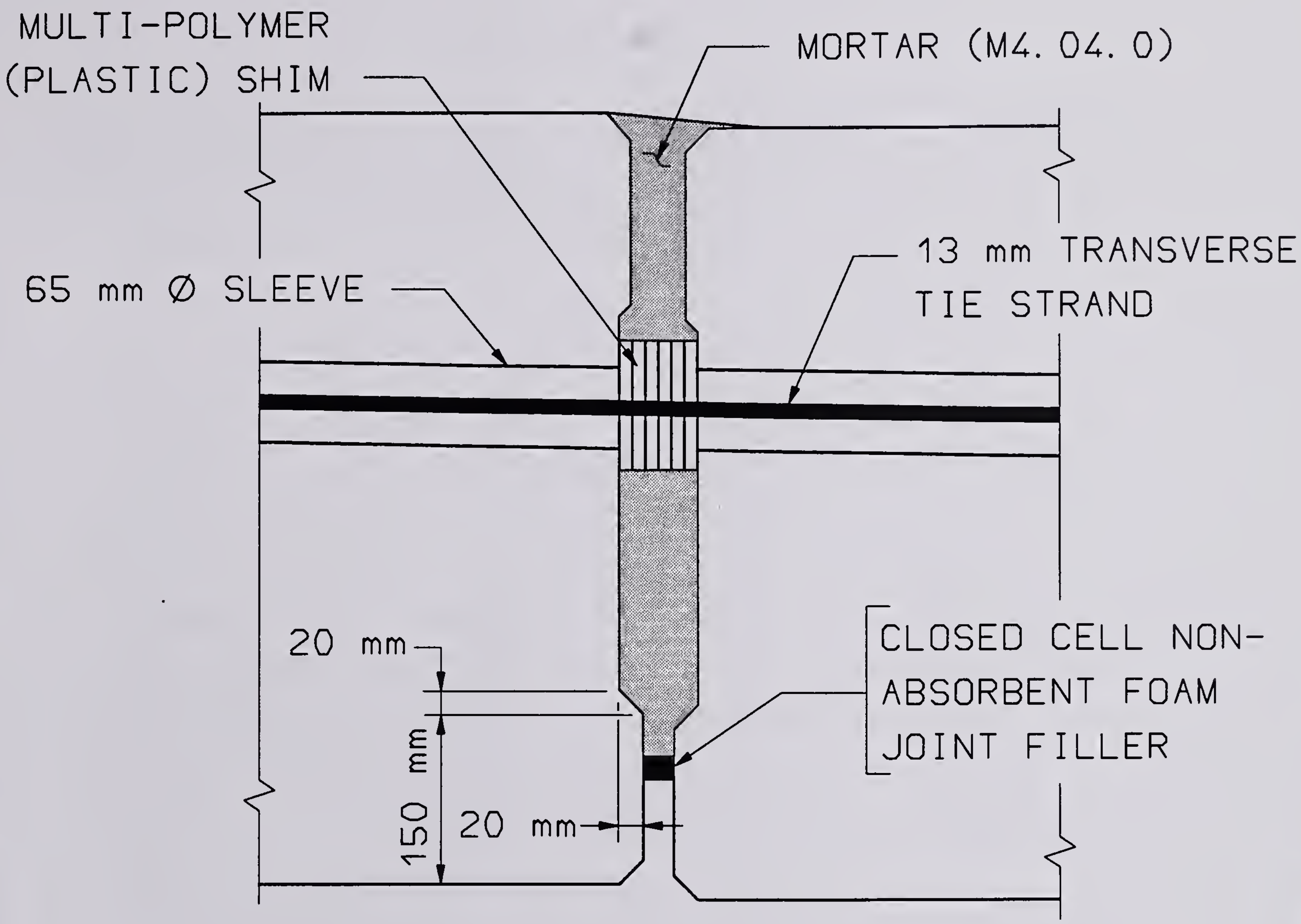
TRANSVERSE TIE TENSIONING NOTES:

1. AFTER ALL BEAMS HAVE BEEN ERECTED, TENSION EACH TRANSVERSE TIE TO 22 kN. *(See Note 3 below.)*
2. FILL ALL KEYWAYS WITH MORTAR (M4.04.0). IF THE KEYWAYS ARE NOT FILLED WITHIN FIVE DAYS AFTER THE BEAMS ARE ERECTED , THE CONTRACTOR SHALL COVER AND PROTECT THE KEYWAYS FROM THE WEATHER AND DEBRIS UNTIL THEY ARE FILLED.
3. AFTER THE MORTAR HAS CURED, TENSION EACH TRANSVERSE TIE TO 135 kN. NO TRAFFIC OR HEAVY EQUIPMENT WILL BE PERMITTED ON THE BEAMS UNTIL ALL TIES HAVE BEEN FULLY TENSIONED.
   (The above note applies to Type BI MOD., BI, and BII Beams only.)
3. AFTER THE MORTAR HAS CURED, AT EACH TRANSVERSE TIE LOCATION TENSION THE BOTTOM TIE TO 68 kN THEN THE TOP TIE TO 68 kN REPEAT THE SEQUENCE ONCE MORE SO THAT EACH STRAND HAS 135 kN OF TENSION. NO TRAFFIC OR HEAVY EQUIPMENT WILL BE PERMITTED ON THE BEAMS UNTIL ALL TIES HAVE BEEN FULLY TENSIONED.
   (The above note applies to Type BIII, BIV, and BIV MOD. Beams only.)
4. CONCRETE FOR SIDEWALK, CURB AND/OR BARRIER SECTIONS SHALL BE PLACED AFTER THE TRANSVERSE TIES HAVE BEEN FULLY TENSIONED.

NOTES:

1. *Adjust the above notes as necessary to conform to stage construction.*
2. *See Dwg. No. 4.2.22 for skews > 30°.*
3. *Where the total initial tensioning force of all the transverse ties is sufficient to displace the exterior beams, the designer shall modify these notes to require the placement of shims between beams. The designer shall specify the type, number, and location of these shims. The shims shall be placed between as many beams as is required such that the total initial tensioning force does not displace any beams.*

MASS HIGHWAY BRIDGE MANUAL	TRANS. TIE TENSIONING NOTES SKEWS ≤ 30° PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.20**


MULTI-POLYMER (PLASTIC) SHIM
MORTAR (M4. 04. 0)
65 mm Ø SLEEVE
13 mm TRANSVERSE TIE STRAND
20 mm
150 mm
20 mm
CLOSED CELL NON-ABSORBENT FOAM JOINT FILLER

NOTES:

1. SEE SECTION 1 FOR JOINT DETAILS NOT SHOWN HERE.
2. SEE TRANSVERSE TIE TENSIONING NOTES FOR TENSIONING PROCEDURES.

SECTION 2 *(SKEW > 30°)*

NOT TO SCALE

NOTES:

1. *See Dwg No. 4.2.19 for skews less than or equal to 30°.*
2. *Add bottom transverse strand with shim to this drawing for Type BIII, BIV, and BIV Mod. beams.*

MASS HIGHWAY BRIDGE MANUAL	TRANSVERSE TIE DETAIL SKEW > 30° PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.21**

FOR SKEWS > 30°:

TRANSVERSE TIE TENSIONING NOTES:

1. AS EACH BEAM IS BEING ERECTED, INSTALL THE TRANSVERSE TIES WITH MULTIPOLYMER (PLASTIC) SHIMS BETWEEN THE BEAMS AT EACH TRANSVERSE TIE LOCATION (AS SHOWN IN SECTION 2).

2. SECURE EACH BEAM TO THE PRECEDING BEAM BY TENSIONING EACH TRANSVERSE TIE TO 135 kN BEFORE ERECTING THE NEXT BEAM.
(The above note applies to Type BI MOD., BI, and BII Beams only.)

2. SECURE EACH BEAM TO THE PRECEDING BEAM BY FIRST TENSIONING THE BOTTOM TIE AT EACH TRANSVERSE TIE LOCATION TO 68 kN THEN THE TOP TIE TO 68 kN REPEAT THE SEQUENCE ONCE MORE SO THAT EACH TIE HAS 135 kN OF TENSION BEFORE ERECTING THE NEXT BEAM.
(The above note applies to Type BIII, BIV, and BIV MOD. Beams only.)

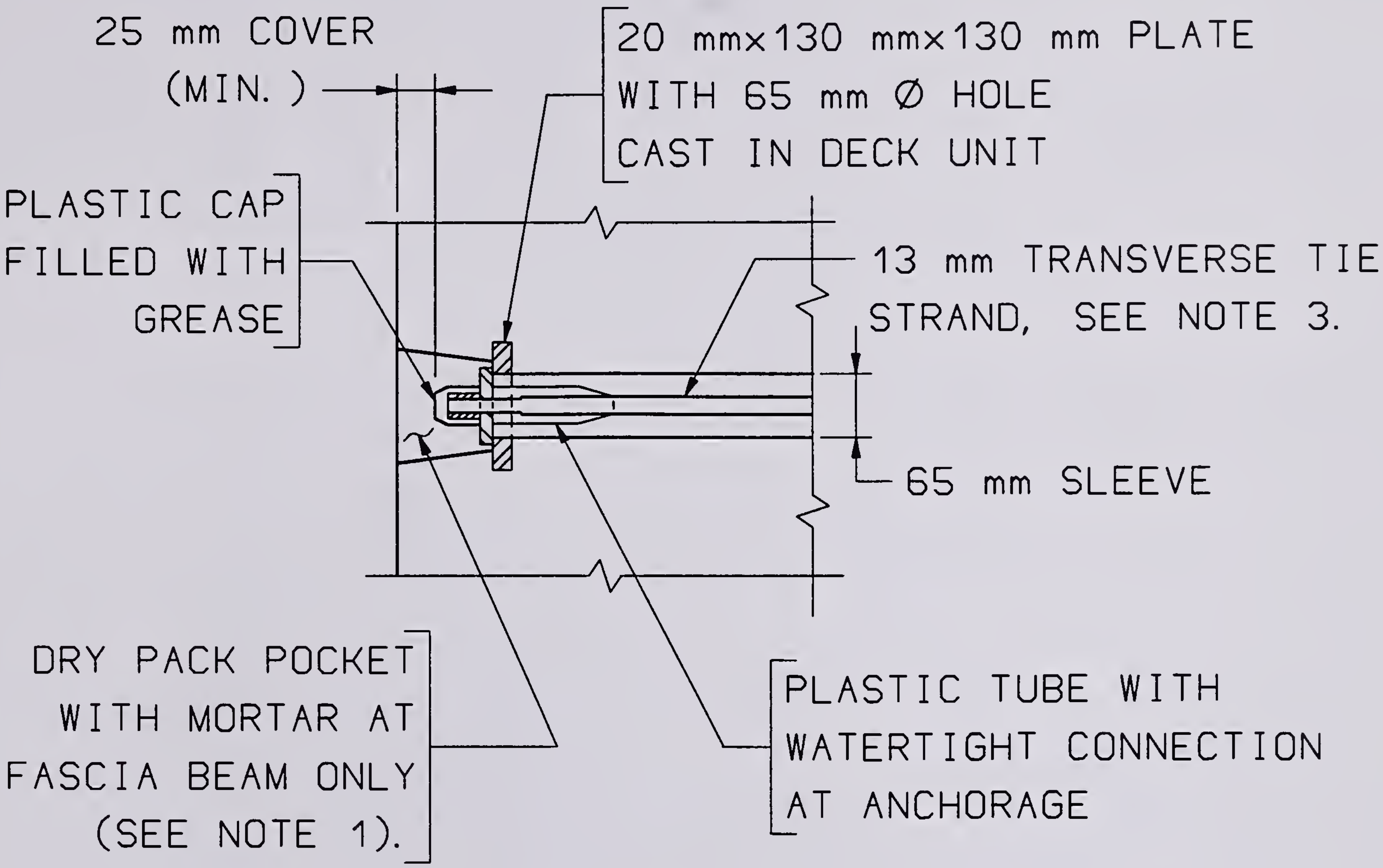
3. FILL ALL KEYWAYS WITH MORTAR (M4.04.0) AFTER TRANSVERSE TIES HAVE BEEN TENSIONED. IF THE KEYWAYS ARE NOT FILLED WITHIN FIVE DAYS AFTER THE BEAMS ARE ERECTED, THE CONTRACTOR SHALL COVER AND PROTECT THE KEYWAYS FROM THE WEATHER AND DEBRIS UNTIL THEY ARE FILLED. NO TRAFFIC OR HEAVY EQUIPMENT WILL BE PERMITTED ON THE BEAMS UNTIL ALL KEYWAYS HAVE BEEN FILLED AND THE MORTAR HAS CURED.

4. CONCRETE FOR SIDEWALK, CURB AND/OR BARRIER SECTIONS SHALL BE PLACED AFTER THE MORTAR HAS CURED.

NOTE:

1. Adjust the above notes as necessary to conform to stage construction.
2. See Dwg. No. 4.2.20 for skews ≤ 30°.

MASS HIGHWAY BRIDGE MANUAL	TRANS. TIE TENSIONING NOTES SKEWS > 30° PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.22**


25 mm COVER (MIN.)
20 mm×130 mm×130 mm PLATE WITH 65 mm Ø HOLE CAST IN DECK UNIT
PLASTIC CAP FILLED WITH GREASE
13 mm TRANSVERSE TIE STRAND, SEE NOTE 3.
65 mm SLEEVE
DRY PACK POCKET WITH MORTAR AT FASCIA BEAM ONLY (SEE NOTE 1).
PLASTIC TUBE WITH WATERTIGHT CONNECTION AT ANCHORAGE

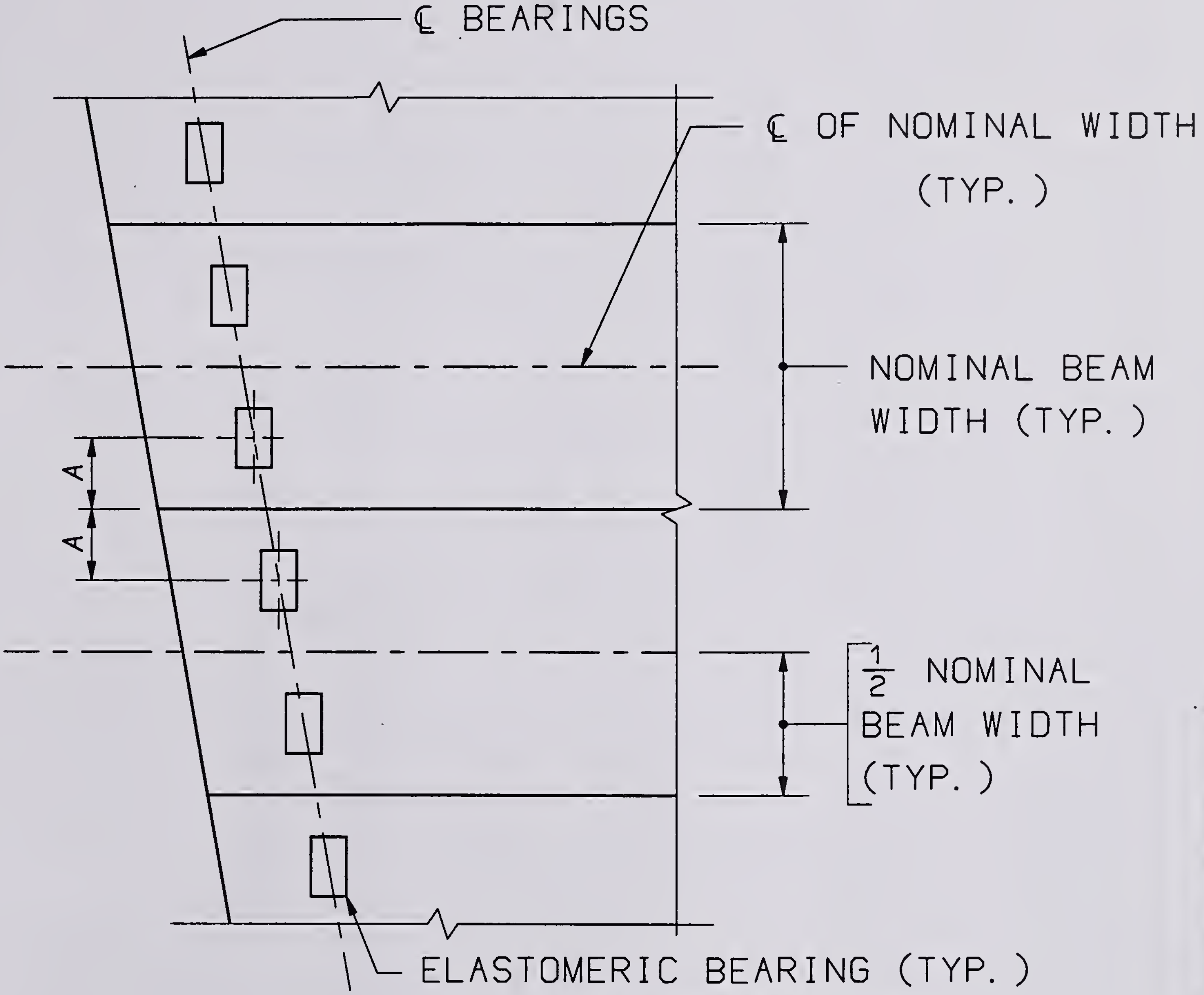
NOTES:

1. MORTAR FOR EXTERIOR POCKETS SHALL CONFORM TO M4.02.15 AND SHALL BE THE SAME COLOR AND TEXTURE AS THE BEAM CONCRETE.
2. OTHER ANCHORAGE SYSTEMS MAY BE SUBSTITUTED WITH THE APPROVAL OF THE ENGINEER. ALTERNATE ANCHORAGE SYSTEMS SHALL BE WATERTIGHT AND CORROSION PROOF.
3. TRANSVERSE TIES SHALL BE COVERED BY A SEAMLESS POLYPROPYLENE SHEATH (WITH CORROSION INHIBITING GREASE BETWEEN THE STRAND AND SHEATH) FOR THE FULL LENGTH OF THE STRAND EXCEPT AT THE ANCHORAGE LOCATION.

TRANSVERSE TIE POCKET DETAIL

SCALE 1:10

MASS HIGHWAY BRIDGE MANUAL	TRANSVERSE TIE ANCHORAGE PRECAST CONCRETE BOX BEAMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.2.23**


℄ BEARINGS
℄ OF NOMINAL WIDTH (TYP.)
NOMINAL BEAM WIDTH (TYP.)
A
A
1/2 NOMINAL BEAM WIDTH (TYP.)
ELASTOMERIC BEARING (TYP.)

(Designer shall supply size and material characteristics.)

LAYOUT OF BEARINGS

NOT TO SCALE

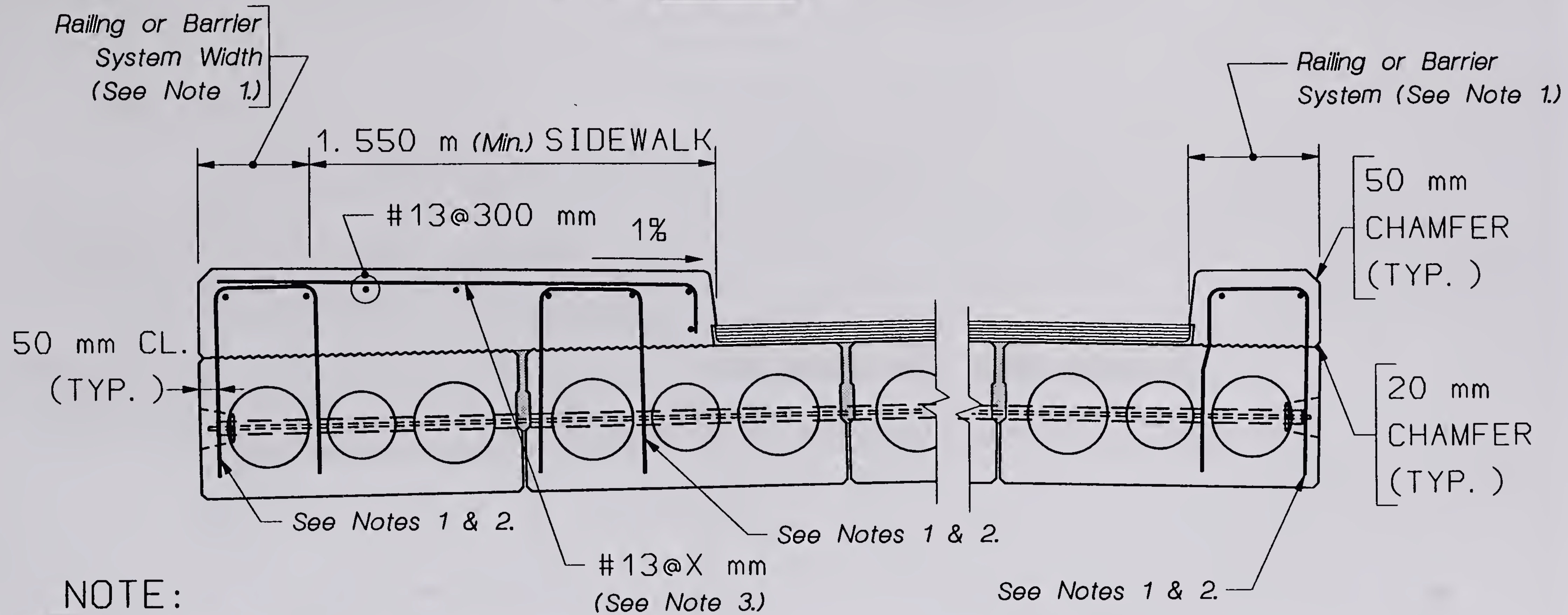
NOTE: *A = (Nominal Width of Beam) ÷ 4*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL LAYOUT OF BEARINGS
PRECAST CONCRETE BOX BEAMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.2.24



NOTE:

SIDEWALK AND SAFETY CURB CONCRETE SHALL BE 35 MPa, 20 mm, 385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.

SIDEWALK SECTION

SAFETY CURB SECTION

NOTES:

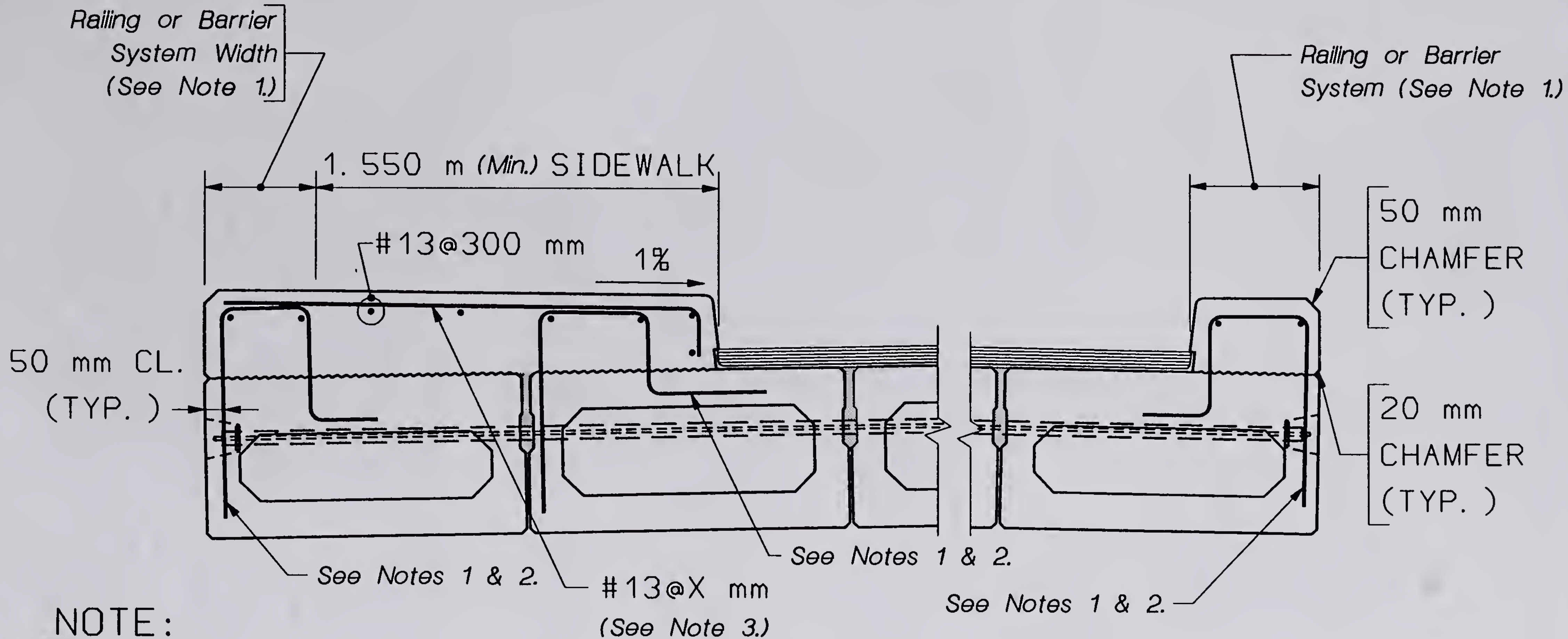
1. See Chapter 9, Railing/Traffic Barrier System for sidewalk and safety curb dimensions, reinforcement and embedment lengths not shown. Modify the sections in Chapter 9 to show the beam arrangement and details shown above. Safety curb for metal rail shown (width shall not be less than 495 mm for S3-PL2 rail), actual safety curb depends on railing/barrier system chosen.
2. Spacing of sidewalk dowels shall be in multiples of the deck beam stirrup reinforcement. Some voids may be altered or eliminated in order to meet the required dowel embedment lengths.
3. Spacing of the transverse sidewalk reinforcement shall be the same as that of the dowels.
4. Sidewalk slab may overhang the exterior beam by a maximum of 75 mm without altering the reinforcement shown. For overhangs greater than 75 mm use the details shown on Dwg. No. 4.3.5.
5. Provide paraffin joints in sidewalk and safety curb.

MASS HIGHWAY
BRIDGE MANUAL

TYP. SIDEWALK & SAFETY CURB DETAILS FOR DECK BEAMS
SIDEWALK & SAFETY CURB DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.3.1



NOTE:

SIDEWALK AND SAFETY CURB CONCRETE SHALL BE 35 MPa, 20 mm, 385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.

SIDEWALK SECTION

SAFETY CURB SECTION

NOTES:

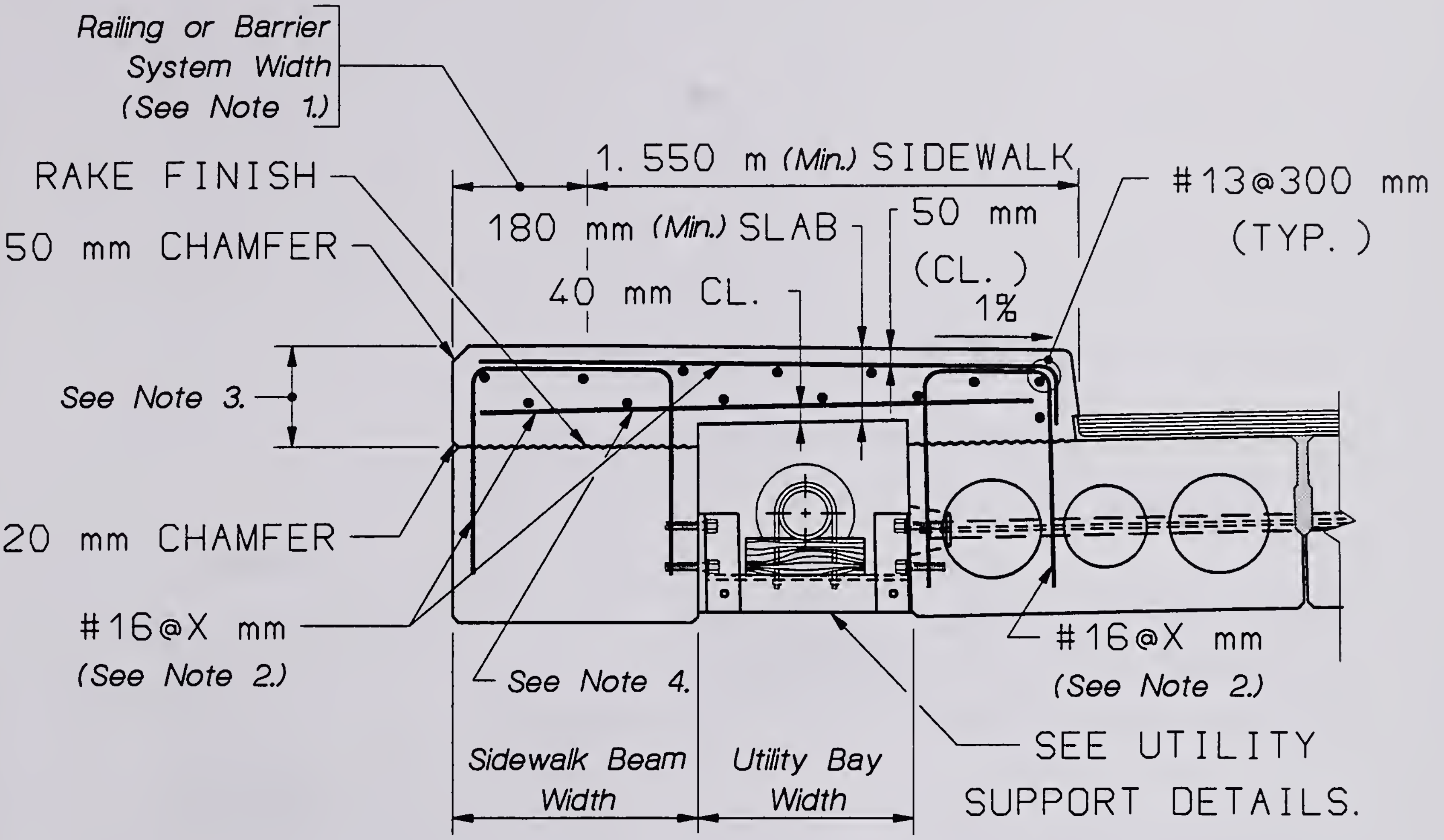
1. See Chapter 9, Railing/Traffic Barrier Systems, for sidewalk and safety curb dimensions, reinforcement and embedmemt lengths not shown. Modify the sections in Chapter 9 to show the beam arrangement and details shown above. Safety curb for metal rail shown (width shall not be less than 495 mm for S3-PL2 rail), actual safety curb depends on railing/barrier system chosen.
2. Spacing of the sidewalk dowels shall be in multiples of the deck beam stirrup reinforcement. The depth of some voids must be decreased in order to meet the required dowel embedment lengths.
3. Spacing of the transverse sidewalk reinforcement shall be the same as that of the dowels.
4. Sidewalk slab may overhang the exterior beam by a maximum of 75 mm without altering the reinforcement shown. For overhangs greater than 75 mm use the details shown on Dwg. No. 4.3.6.
5. Provide paraffin joints in sidewalk and safety curb.

MASS HIGHWAY
BRIDGE
MANUAL

TYP. SIDEWALK & SAFETY CURB
DETAILS FOR BOX BEAMS
SIDEWALK & SAFETY CURB DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.3.2



NOTE:

SIDEWALK CONCRETE SHALL BE 35 MPa, 20 mm, 385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.

SIDEWALK SECTION (SIII AND SIV BEAMS ONLY)

NOTES:

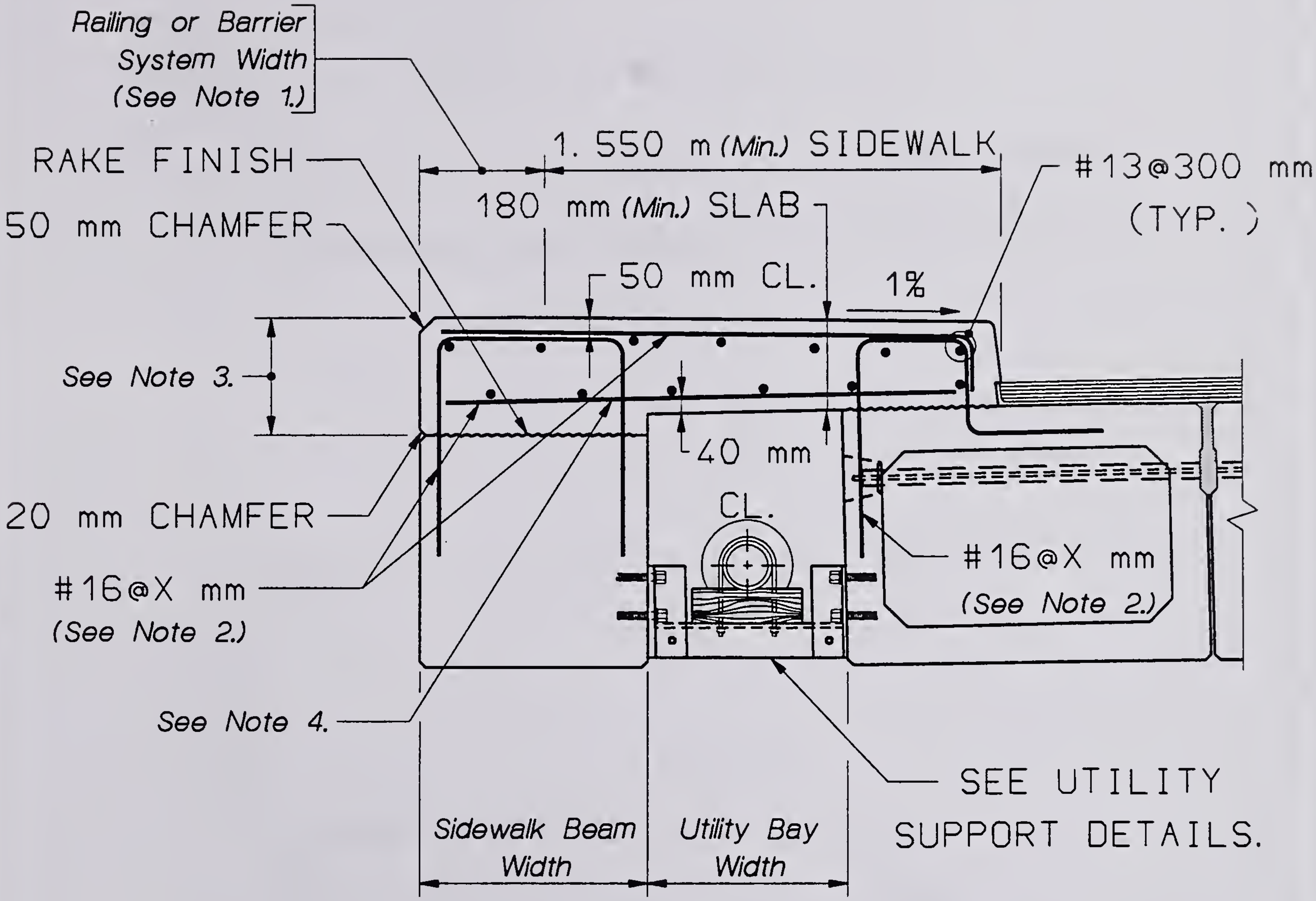
1. *Dimensions shall vary depending on railing or barrier system used. Modify the sections in Chapter 9 to show the beam arrangement and details shown above.*
2. *Spacing of the sidewalk reinforcement shall be designed and shall be spaced in multiples of beam stirrups. The voids may be altered or eliminated in order to properly develop or position the dowel bars.*
3. *Depth of slab over sidewalk beam must be sufficient to embed the bolt or develop the reinforcing of the railing or barrier system.*
4. *The embedment length of the bottom slab reinforcement shall be labelled on both sides of the utility bay (370 mm min.).*
5. *Do not provide paraffin joints in sidewalk.*
6. *For bridges with SI Beams, SII Beams, large utilities, and/or other restrictive features, use exterior utility supports shown on Dwg. No. 4.3.5.*

MASS HIGHWAY
BRIDGE
MANUAL

SIDEWALK DET. W/UTILITY BAY
(SIII AND SIV BEAMS ONLY)
SIDEWALK & SAFETY CURB DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.3.3



NOTE:

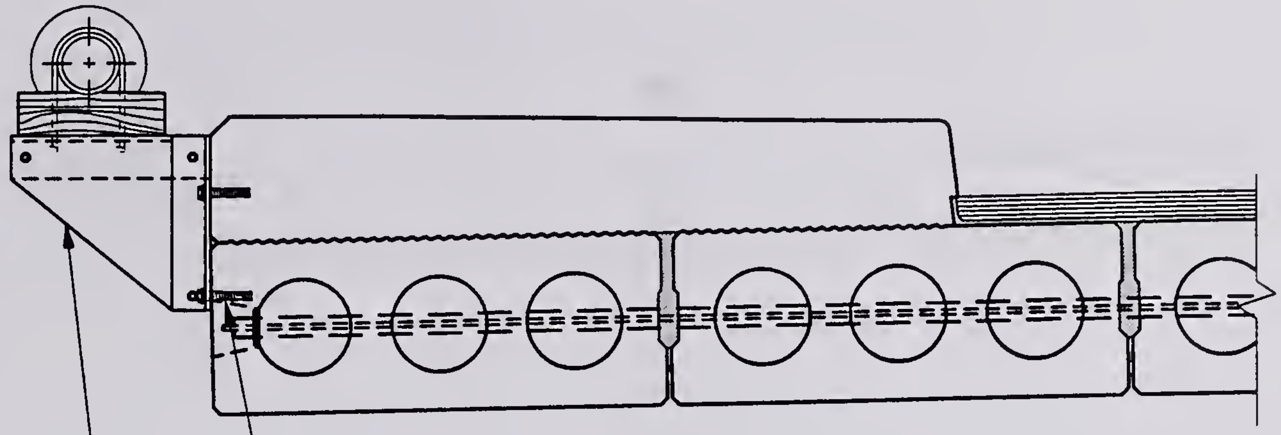
SIDEWALK CONCRETE SHALL BE 35 MPa, 20 mm, 385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.

SIDEWALK SECTION

NOTES:

1. *Dimensions shall vary depending on railing or barrier system used. Modify the sections in Chapter 9 to show the beam arrangement and details shown above.*
2. *Spacing of the sidewalk reinforcement shall be designed and shall be spaced in multiples of beam stirrup/slab reinforcement. Size of bars may be increased to #19 provided that the depth of the slab is sufficient. (Depth of internal void must be decreased to develop a #19 hook.)*
3. *Depth of slab over sidewalk beam must be sufficient to embed the bolt or develop the reinforcing of the railing or barrier system.*
4. *The embedment length of the bottom slab reinforcement shall be labelled on both sides of the utility bay (370 mm min.).*
5. *Do not provide paraffin joints in sidewalk.*
6. *For bridge with large utilities and shallow beams, this detail may not be practical, in which case use exterior utility supports. (See Dwg. No. 4.3.6.)*

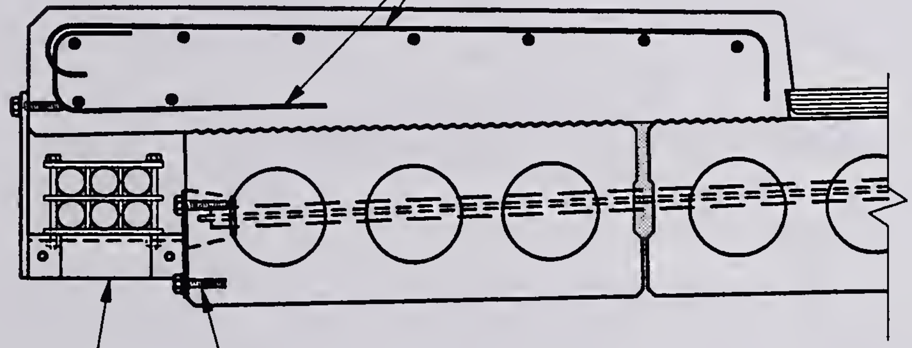
MASS HIGHWAY BRIDGE MANUAL	SIDEWALK DETAILS W/UTILITY BAY FOR BOX BEAMS SIDEWALK & SAFETY CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.3.4**



CAST-IN-PLACE CONCRETE INSERT W/
20 mm Ø H. S. BOLT (TYP.) *(Minimum)*

UTILITY SUPPORT @ 2 m *(See Note 2.)*

See Note 3.



CAST-IN-PLACE CONCRETE INSERT W/
20 mm Ø H. S. BOLT (TYP.) *(Minimum)*

UTILITY SUPPORT @ 2 m *(See Note 2.)*

NOTES:

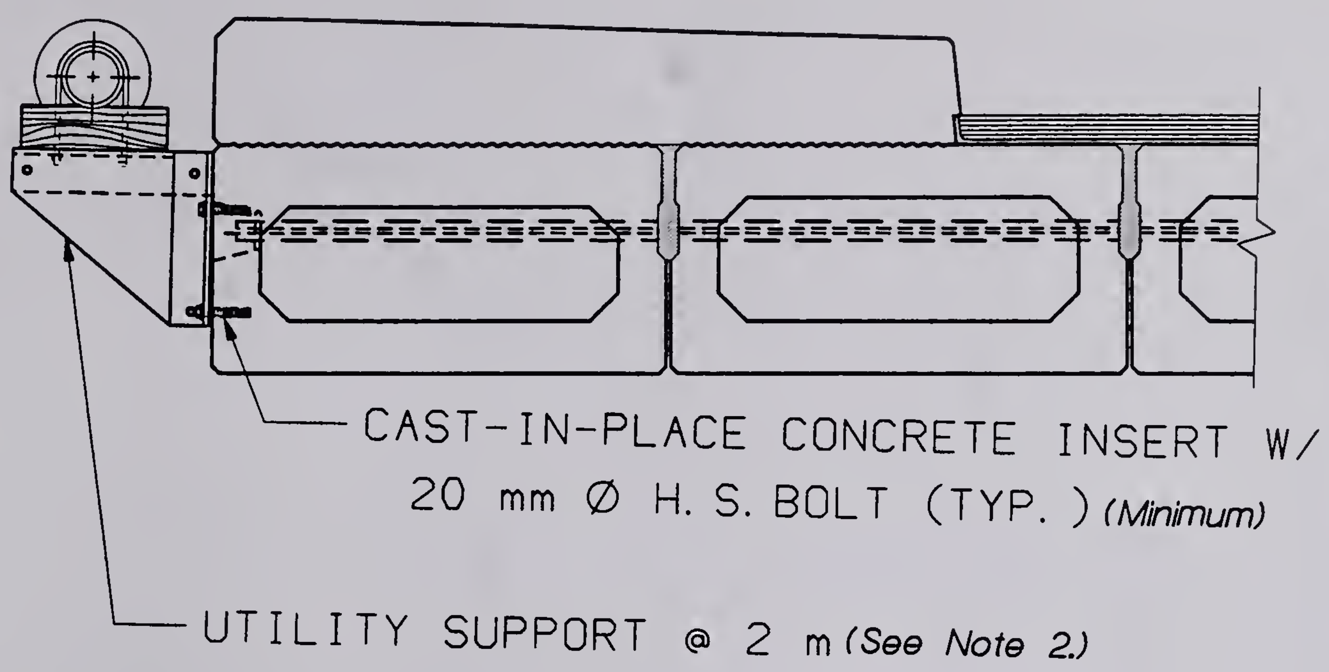
1. *Incorporate the approprate above details with the sidewalk details shown on Dwg. No. 4.3.1.*
2. *The designer shall be responsible for the design of the utility supports and shall check the adequacy of bolts and inserts. Inserts shall be spaced so that they do not interfere with internal voids. The details of the utility support shall be shown on the plans.*
3. *For reinforcement, see Chapter 9, Railing/Traffic Barrier Systems, overhanging sidewalk details.*

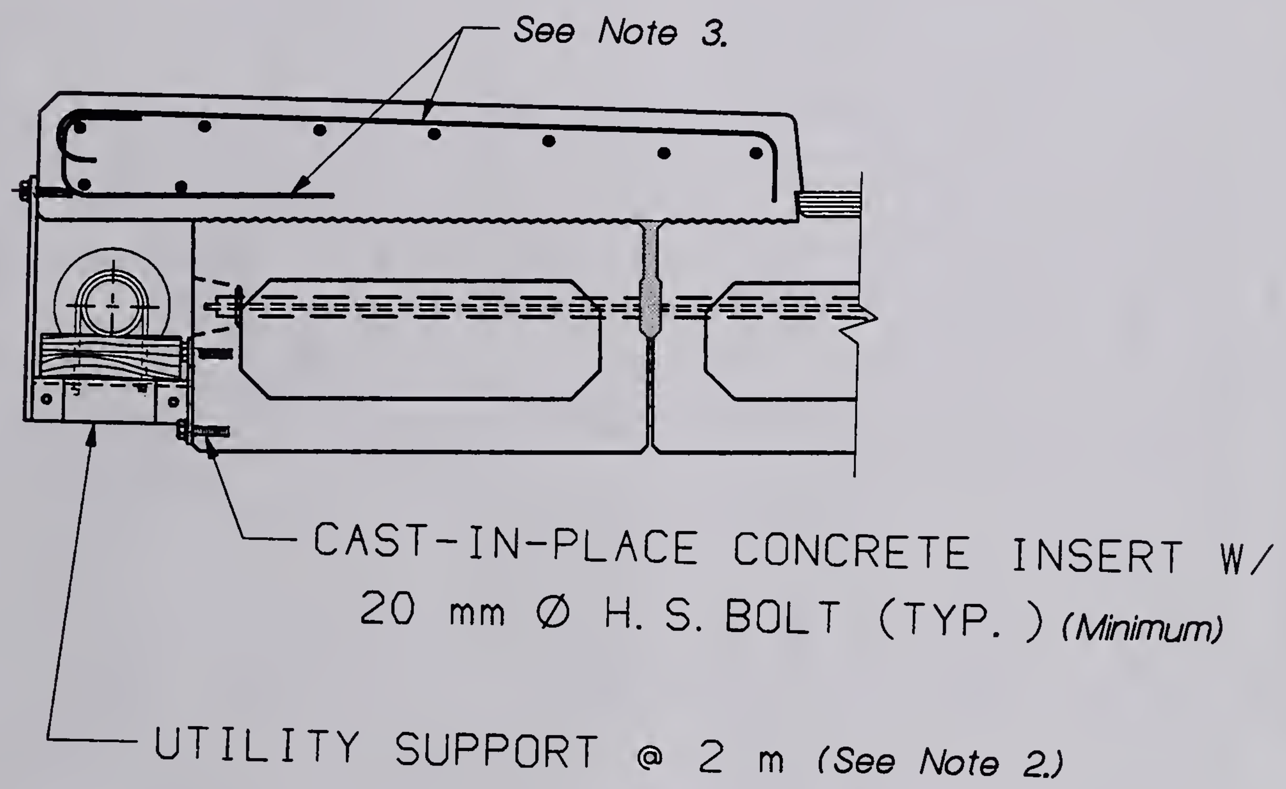
MASS HIGHWAY
BRIDGE
MANUAL

EXTERIOR UTILITY SUPPORTS
FOR DECK BEAMS
SIDEWALK & SAFETY CURB DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.3.5

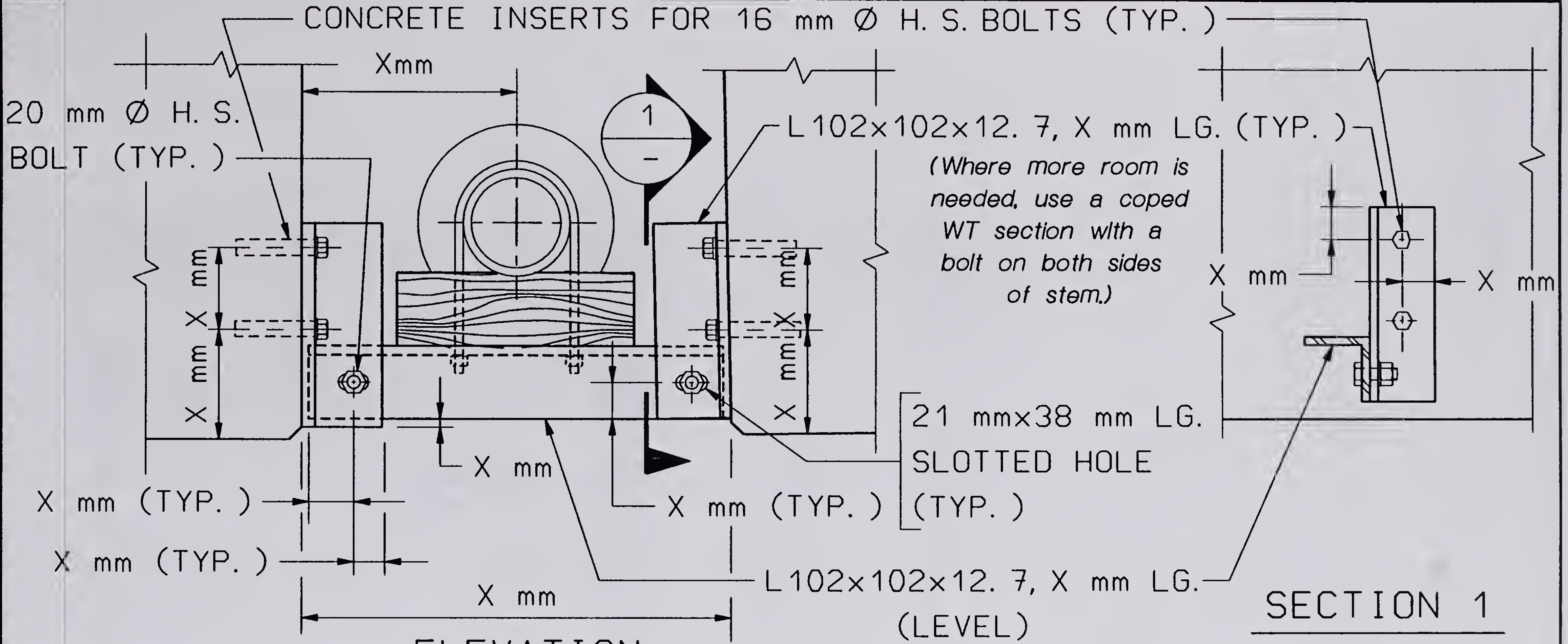

CAST-IN-PLACE CONCRETE INSERT W/
20 mm Ø H. S. BOLT (TYP.) (Minimum)
UTILITY SUPPORT @ 2 m (See Note 2.)


See Note 3.
CAST-IN-PLACE CONCRETE INSERT W/
20 mm Ø H. S. BOLT (TYP.) (Minimum)
UTILITY SUPPORT @ 2 m (See Note 2.)

NOTES:

1. *Incorporate the approprate above details with the sidewalk details shown on Dwg. No. 4.3.2.*
2. *The designer shall be responsible for the design of the utility supports and shall check the adequacy of the bolts and inserts. The details of the utility support shall be shown on the plans.*
3. *For reinforcement, see Chapter 9, Railing/Traffic Barrier Systems, overhanging sidewalk details.*

MASS HIGHWAY BRIDGE MANUAL	EXTERIOR UTILITY SUPPORTS FOR BOX BEAMS SIDEWALK & SAFETY CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.3.6**


CONCRETE INSERTS FOR 16 mm Ø H. S. BOLTS (TYP.)
Xmm
20 mm Ø H. S. BOLT (TYP.)
1
L102x102x12. 7, X mm LG. (TYP.)
(Where more room is needed, use a coped WT section with a bolt on both sides of stem.)
X mm
X mm
X mm
X mm
X mm
X mm
X mm (TYP.)
X mm (TYP.)
X mm (TYP.)
X mm
21 mmx38 mm LG. SLOTTED HOLE (TYP.)
L102x102x12. 7, X mm LG. (LEVEL)
X mm
X mm

ELEVATION

SECTION 1

NOTES:

1. ALL STRUCTURAL STEEL SHALL CONFORM TO AASHTO M270 GR. 250.
2. ALL STRUCTURAL STEEL AND FASTENERS SHALL BE GALVANIZED IN ACCORDANCE WITH AASHTO M111 AND M232.

UTILITY SUPPORT DETAILS

SCALE 1: 10

NOTES:

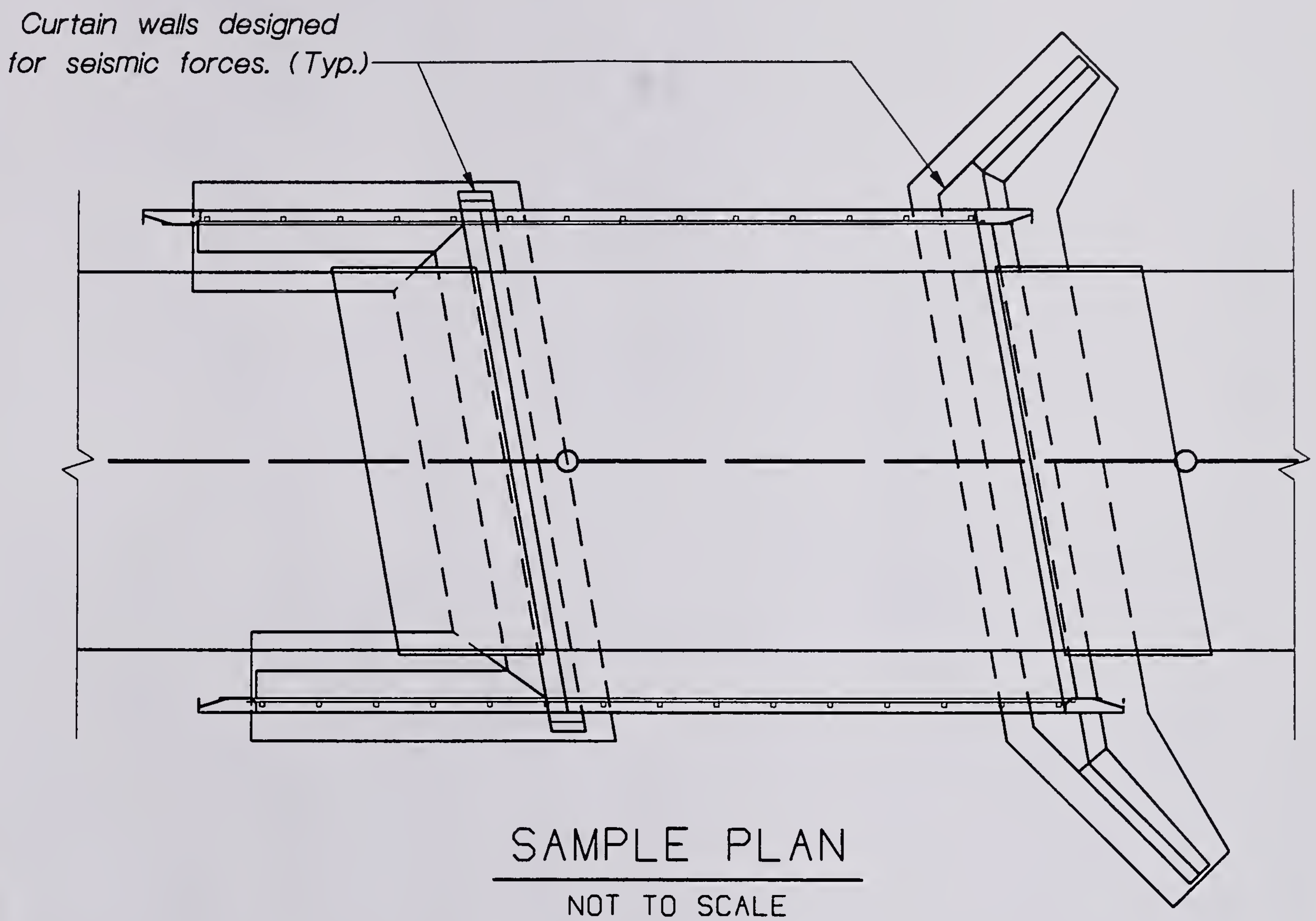
1. *The limits of the utility support detailed above are: max. total utility weight - 3.65 kN/m: max. utility bay width - 1200 mm: max. support spacing - 3 m. If any of these limits are exceeded, the designer shall size the members accordingly.*
2. *Position the bolts such that they meet the standard edge distances and construction requirements and that the inserts do not interfere with strands and reinforcing bars.*

MASS HIGHWAY
BRIDGE MANUAL

TYPICAL UTILITY SUPPORT DETAILS
SIDEWALK & SAFETY CURB DETAILS

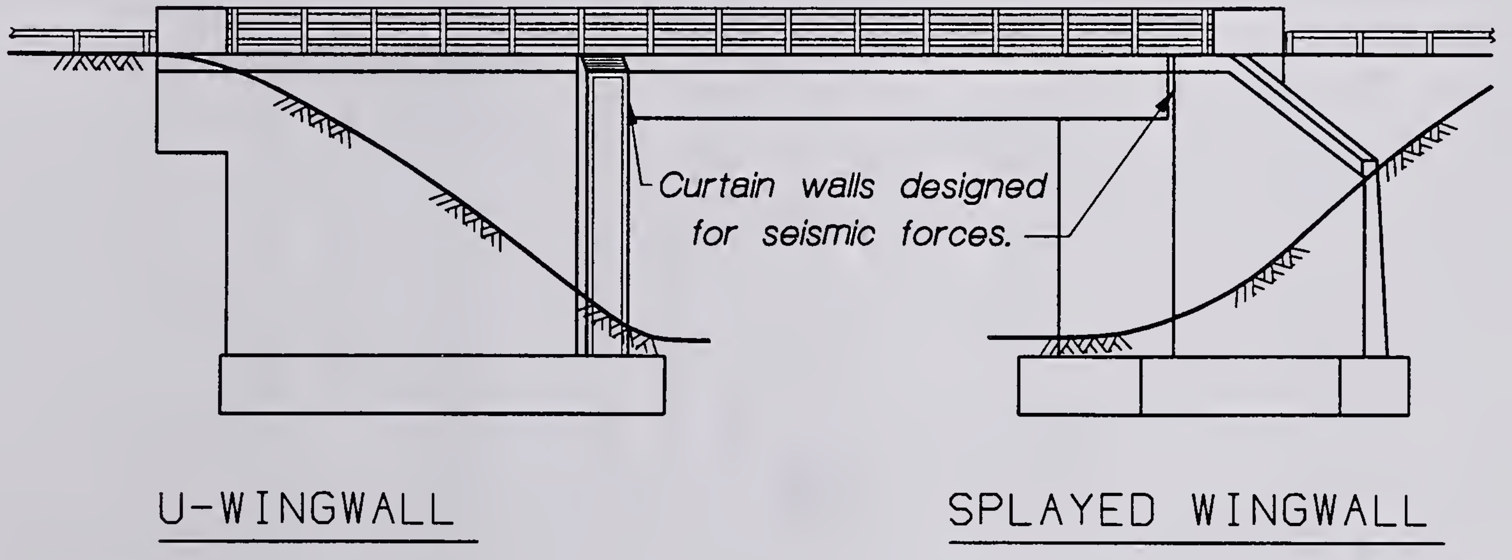
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.3.7



SAMPLE PLAN

NOT TO SCALE



SAMPLE ELEVATION

NOT TO SCALE

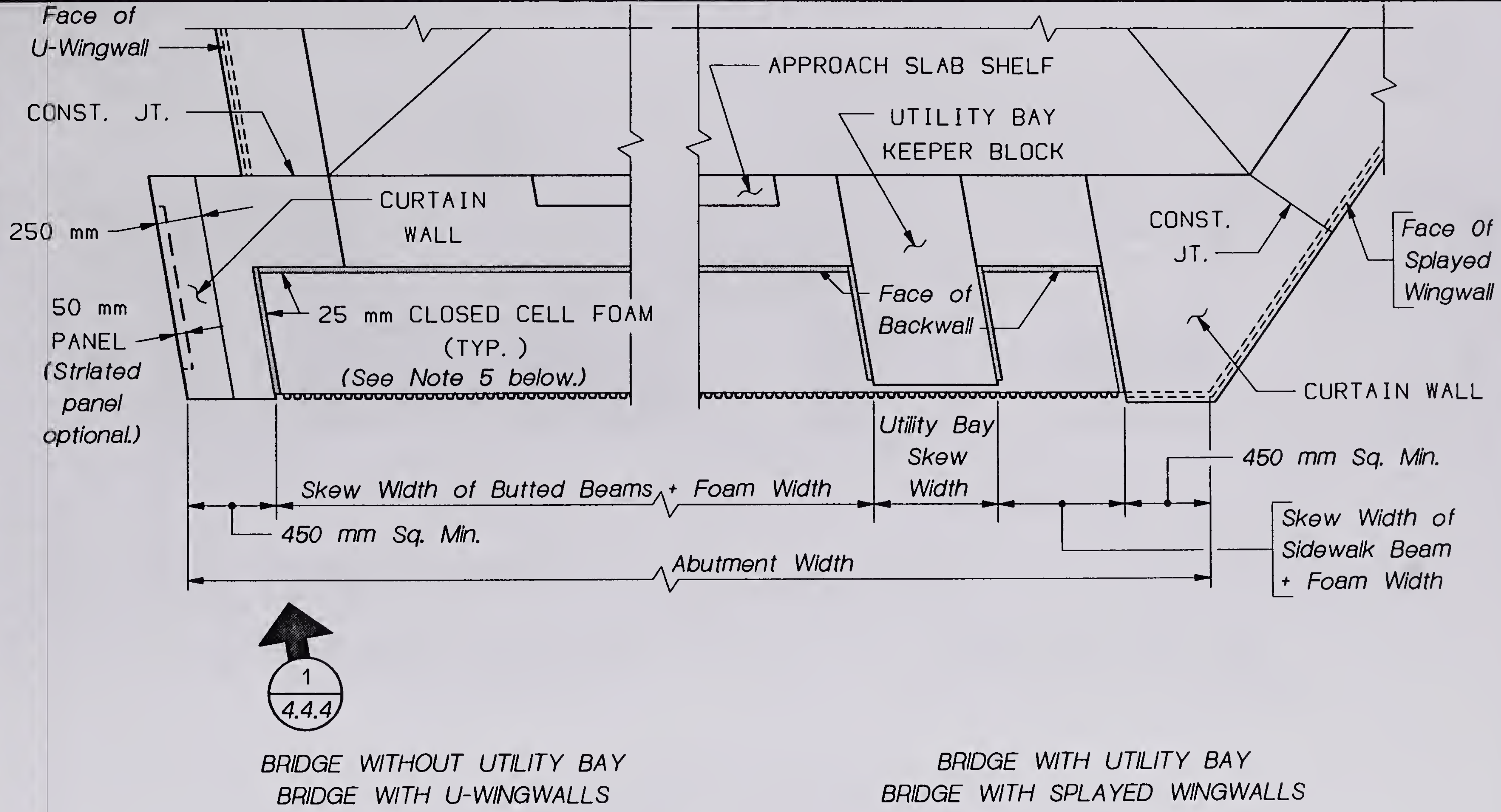
NOTE: *Striations not shown for clarity.*

MASS HIGHWAY
BRIDGE
MANUAL

SAMPLE BRIDGE PLAN
AND ELEVATION
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.1



ABUTMENT PLAN

SCALE(1:50 min.)

NOTES:

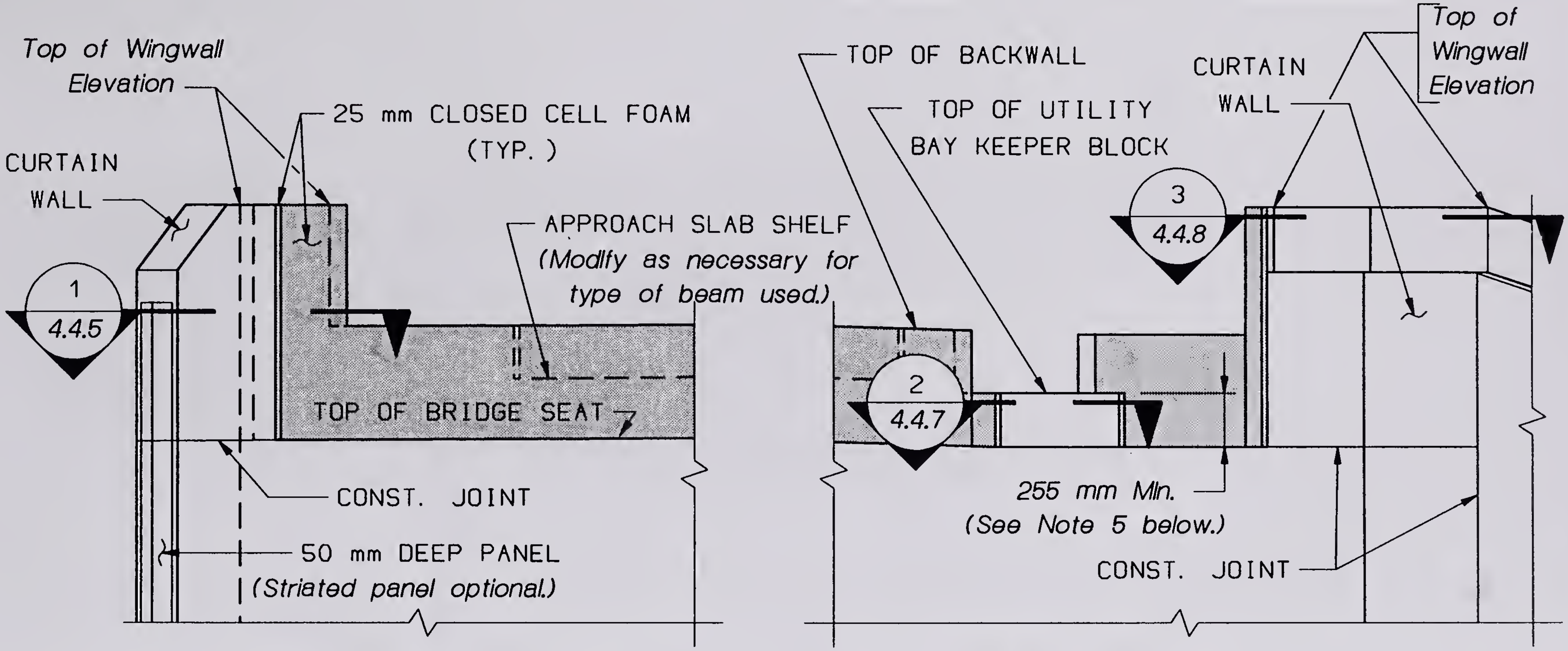
1. Above drawing is not to scale.
2. Utility bay details may be used with either U-wingwalls or splayed wingwalls.
3. Remainder of abutment has been omitted for clarity.
4. Abutment plan shall be drawn without breaks and to scale on the construction plans. Include all relevant dimensions, angles, survey information, and north arrow.
5. The thickness of the closed cell foam may be increased as necessary to accomodate thermal expansion.

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL PLAN
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.2


Top of Wingwall Elevation
CURTAIN WALL
1
4.4.5
25 mm CLOSED CELL FOAM (TYP.)
APPROACH SLAB SHELF (Modify as necessary for type of beam used.)
TOP OF BRIDGE SEAT
CONST. JOINT
50 mm DEEP PANEL (Striated panel optional.)
TOP OF BACKWALL
TOP OF UTILITY BAY KEEPER BLOCK
2
4.4.7
CURTAIN WALL
Top of Wingwall Elevation
3
4.4.8
255 mm Min. (See Note 5 below.)
CONST. JOINT

BRIDGE WITHOUT UTILITY BAY
BRIDGE WITH U-WINGWALLS

BRIDGE WITH UTILITY BAY
BRIDGE WITH SPLAYED WINGWALLS

ABUTMENT ELEVATION

SCALE(1:50 *min.*)

NOTES:

1. *Above detail is not drawn to scale.*
2. *Utility bay details may be used with either U-wingwalls or splayed wingwalls.*
3. *Remainder of abutment has been omitted for clarity.*
4. *Abutment elevation shall be drawn without breaks and to scale on the construction plans. Include all relevant elevations.*
5. *If the 255 mm minimum height of the utility bay keeper block interferes with the placement of the utilities, the designer shall design an alternate method to brace the beams laterally for seismic loads.*
6. *Striations not shown for clarity.*

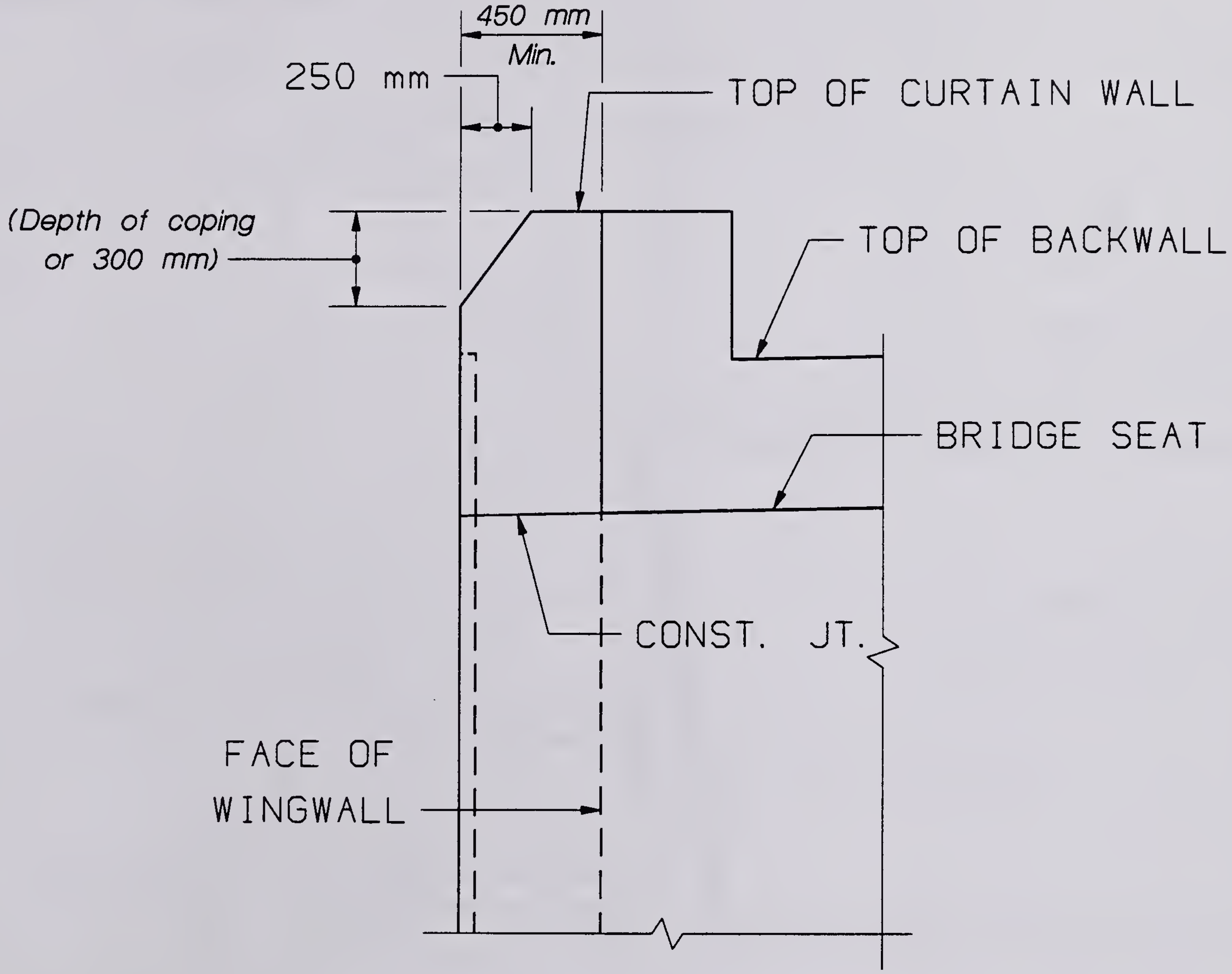
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL ELEVATION

ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.3

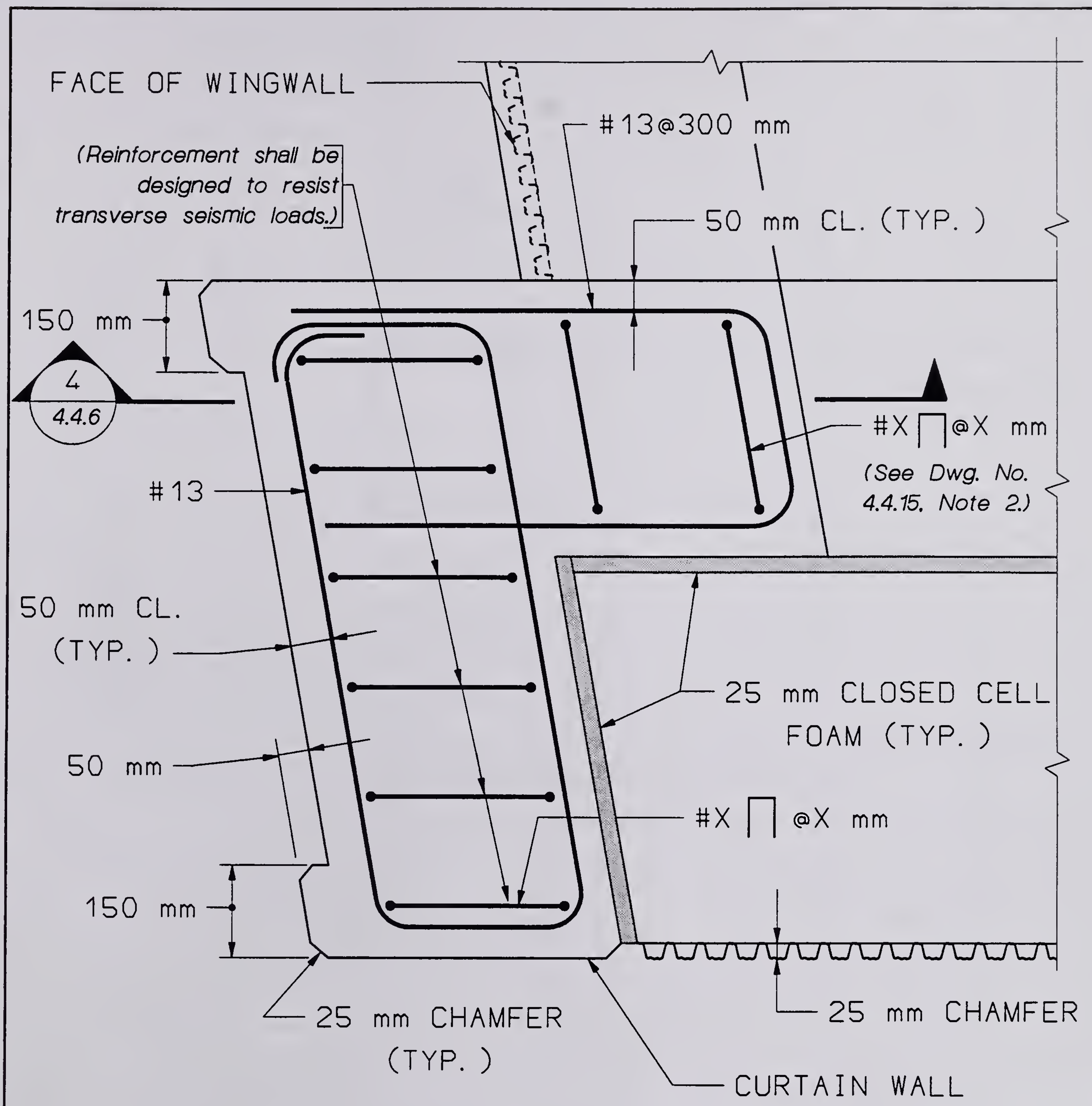


NOTE: STRIATIONS NOT SHOWN FOR CLARITY.

VIEW 1

SCALE 1:25

MASS HIGHWAY BRIDGE MANUAL	DETAIL @ U-WINGWALL CORNER ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.4.4**



NOTE:

ATTACH CLOSED CELL FOAM TO THE BACK AND SIDE OF THE EXTERIOR PRECAST BEAM PRIOR TO PLACING THE CONCRETE FOR THE BACKWALL AND CURTAIN WALL.

SECTION 1

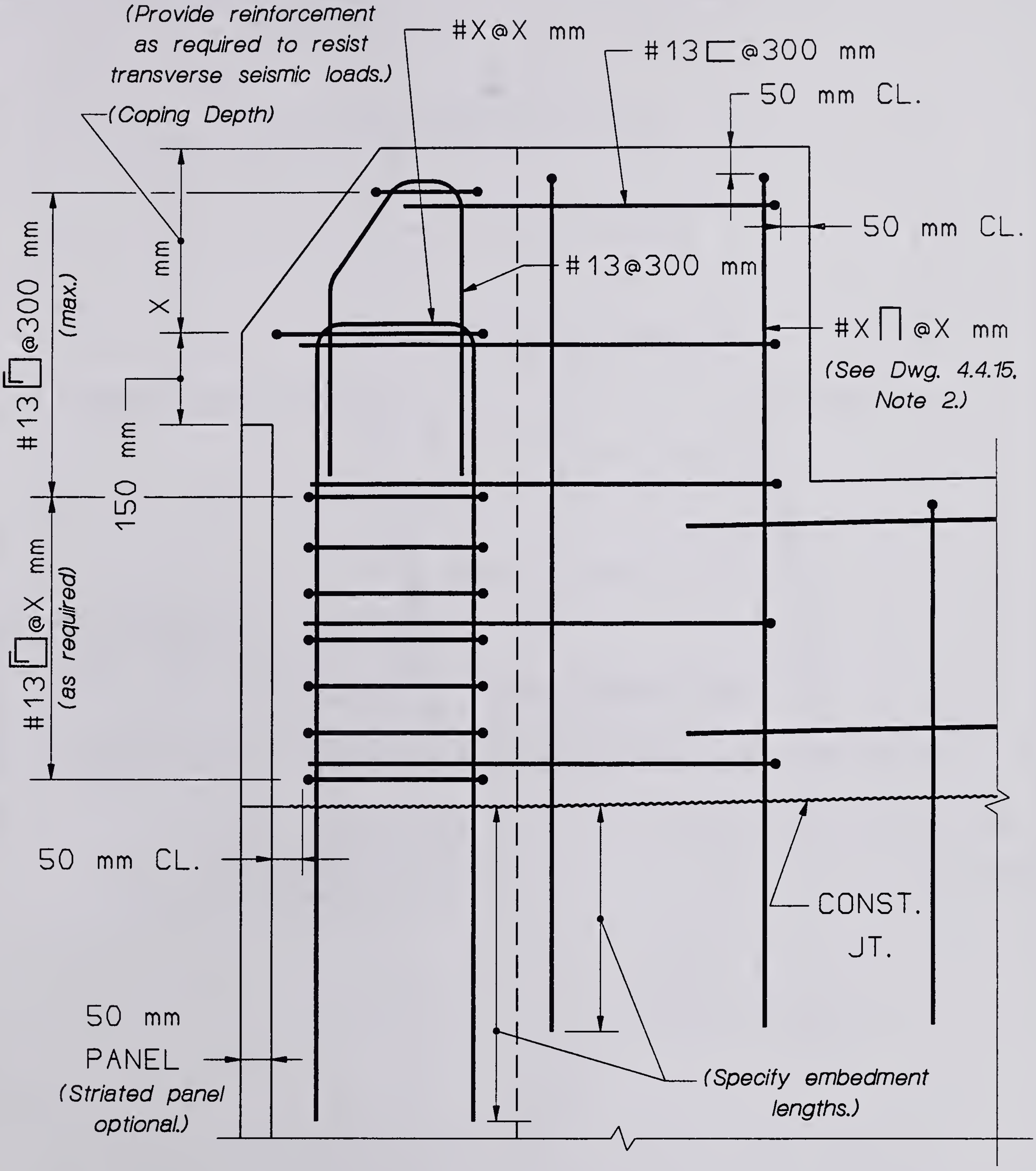
SCALE 1: 10

MASS HIGHWAY
BRIDGE
MANUAL

PLAN SECTION @ ABUT. END
U-WINGWALLS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.5


(Provide reinforcement as required to resist transverse seismic loads.)
(Coping Depth)
#X@X mm
#13⊏@300 mm
50 mm CL.
50 mm CL.
#13@300 mm
X mm
#13⌐@300 mm (max.)
150 mm
#X⊓@X mm
(See Dwg. 4.4.15, Note 2.)
#13⌐@X mm (as required)
50 mm CL.
CONST. JT.
50 mm PANEL
(Striated panel optional.)
(Specify embedment lengths.)

NOTE:

REINFORCEMENT BELOW CONSTRUCTION JOINT HAS BEEN OMITTED FOR CLARITY.

SECTION 4

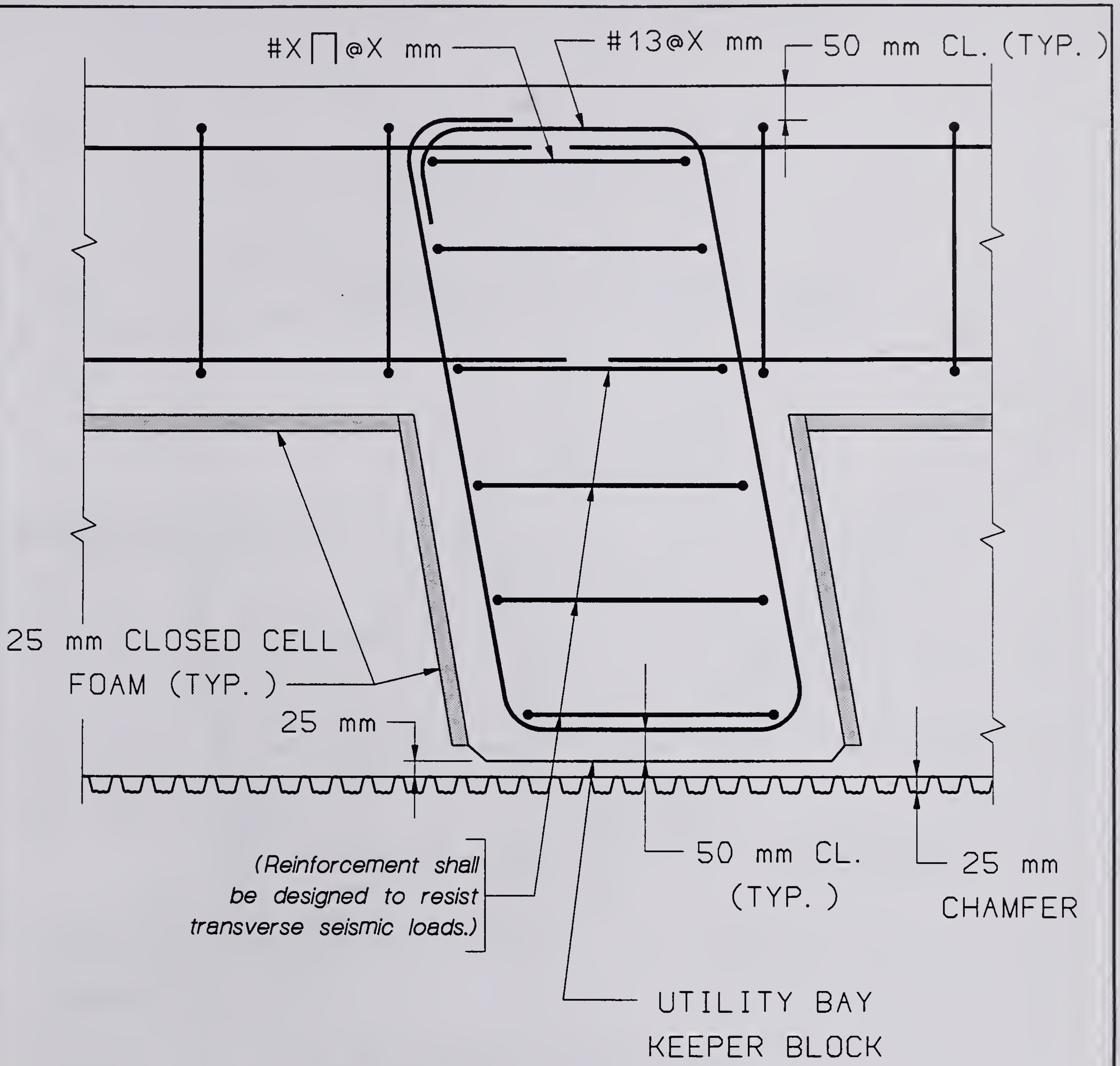
SCALE 1:10

MASS HIGHWAY
BRIDGE MANUAL

VERT. SECTION @ ABUT. END
U-WINGWALLS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.6


#X⊓@X mm
#13@X mm
50 mm CL. (TYP.)
25 mm CLOSED CELL FOAM (TYP.)
25 mm
(Reinforcement shall be designed to resist transverse seismic loads.)
50 mm CL. (TYP.)
25 mm CHAMFER
UTILITY BAY KEEPER BLOCK

NOTE:

ATTACH CLOSED CELL FOAM TO THE BACK AND SIDE OF THE PRECAST BEAMS PRIOR TO PLACING THE CONCRETE FOR THE BACKWALL AND UTILITY BAY KEEPER BLOCK.

SECTION 2

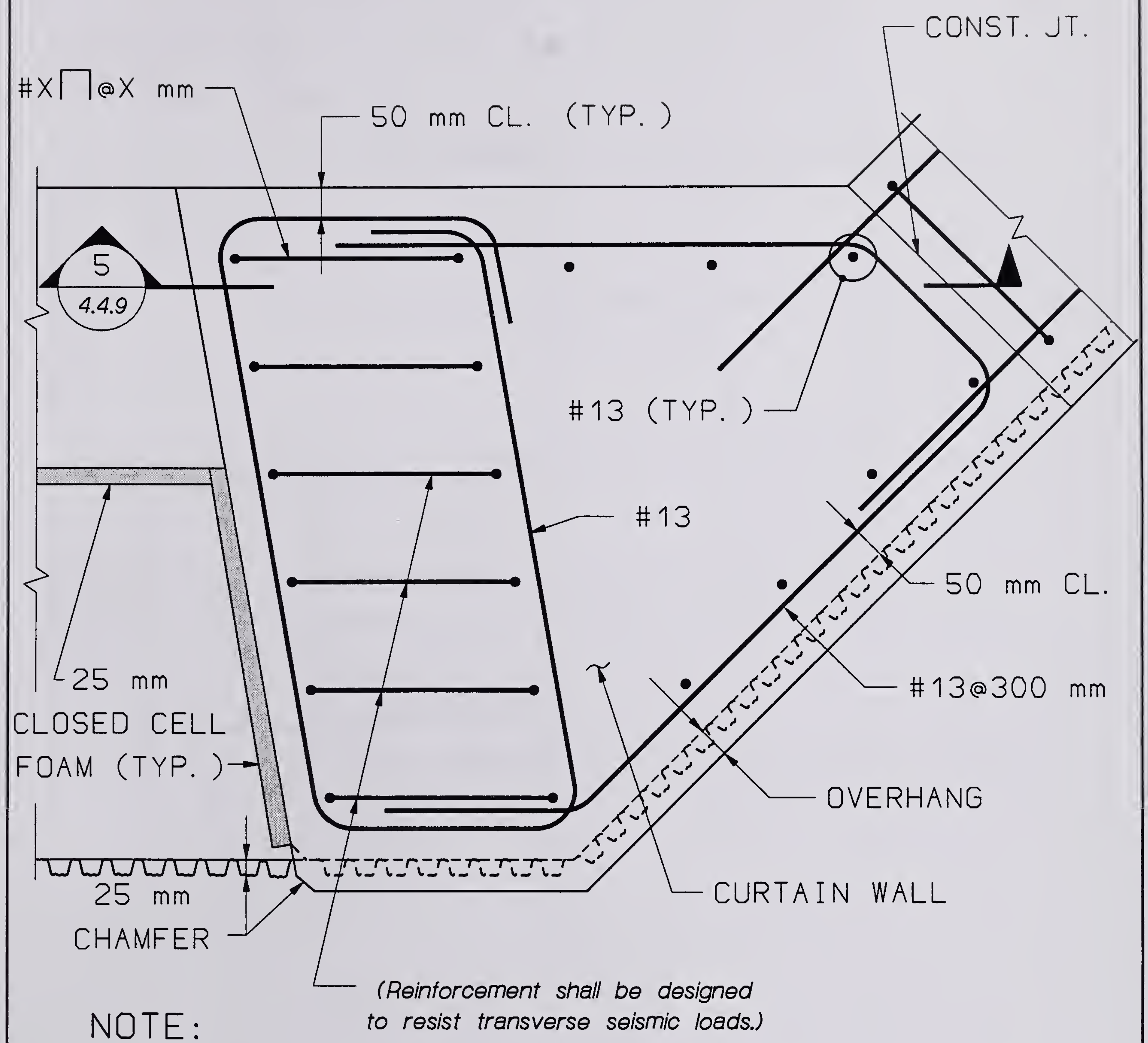
SCALE 1:10

MASS HIGHWAY
BRIDGE
MANUAL

PLAN SECTION @ UTILITY BAY
KEEPER BLOCK
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.7



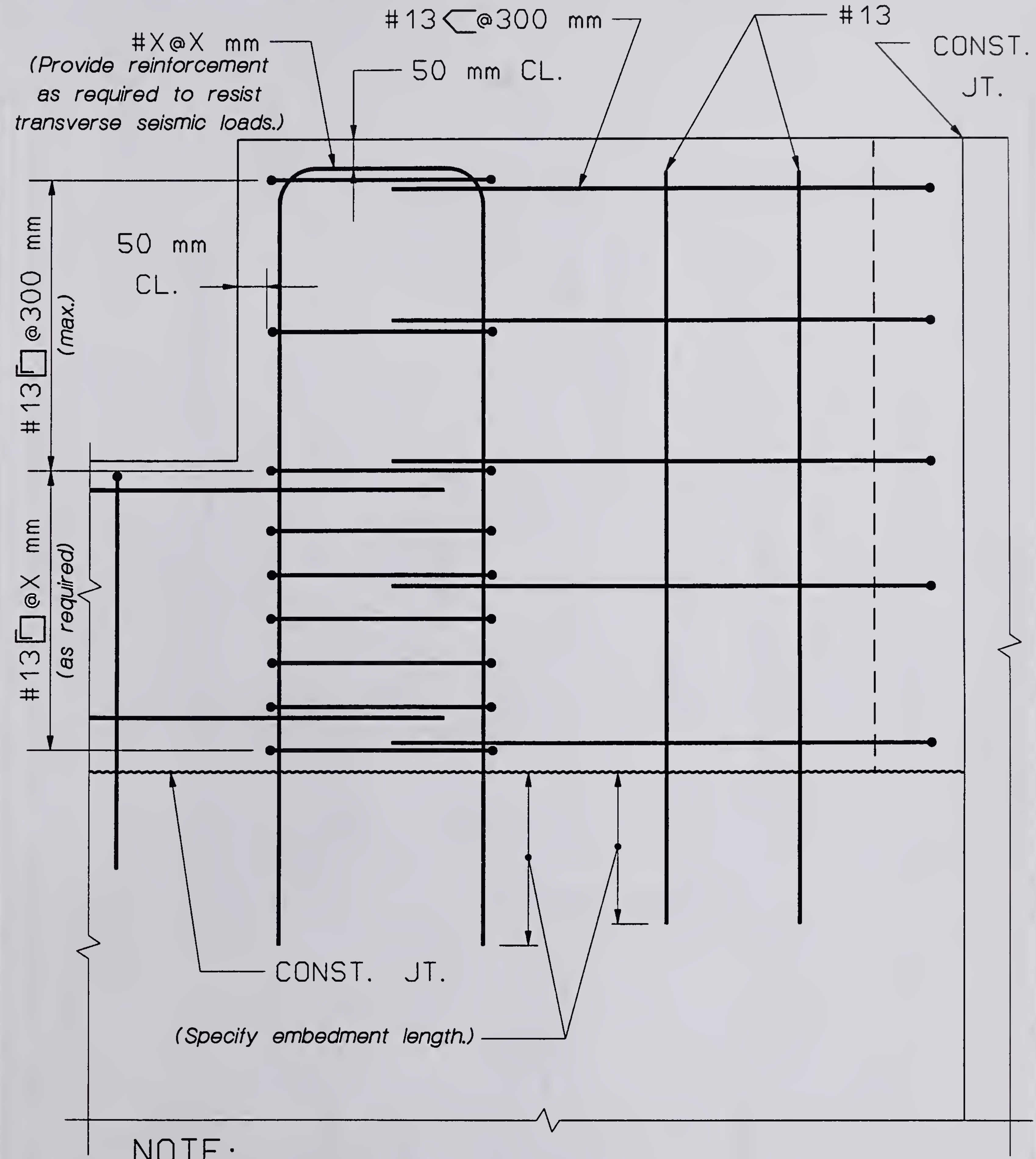
NOTE:

ATTACH CLOSED CELL FOAM TO THE BACK AND SIDE OF THE EXTERIOR PRECAST BEAM PRIOR TO PLACING THE CONCRETE FOR THE BACKWALL AND CURTAIN WALL.

SECTION 3

SCALE 1: 10

MASS HIGHWAY BRIDGE MANUAL	PLAN SECTION @ ABUT. END SPLAYED WINGWALLS ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.4.8


#X@X mm
(Provide reinforcement as required to resist transverse seismic loads.)
#13 ⊏ @300 mm
50 mm CL.
#13
CONST. JT.
50 mm CL.
#13 ⊏ @300 mm (max.)
#13 ⊏ @X mm (as required)
CONST. JT.
(Specify embedment length.)

NOTE:

REINFORCEMENT BELOW CONSTRUCTION JOINT HAS BEEN OMITTED FOR CLARITY.

SECTION 5

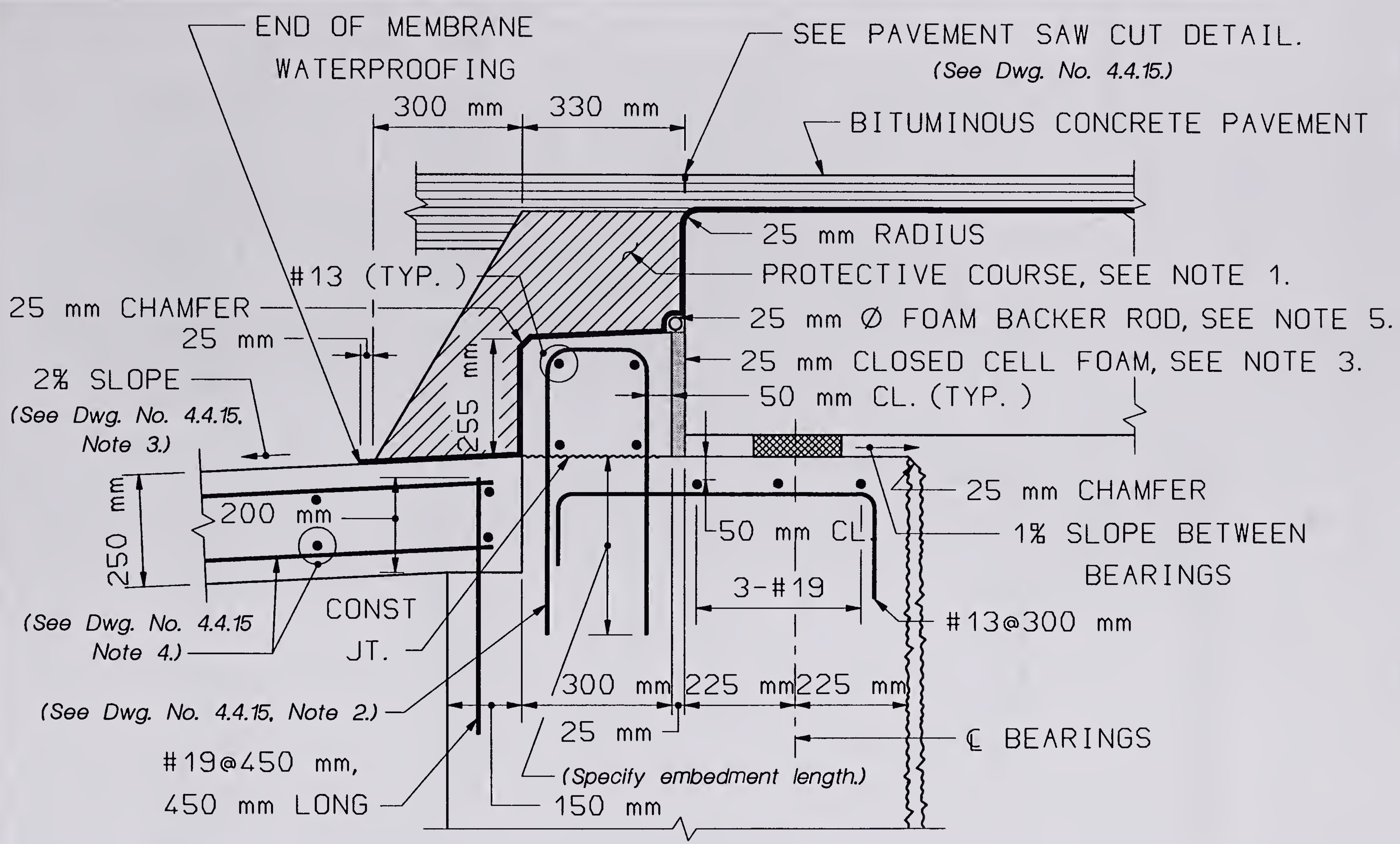
SCALE 1: 10

MASS HIGHWAY
BRIDGE MANUAL

VERT. SECTION @ ABUT. END SPLAYED WINGWALLS
ABUTMENT DETAILS

DATE OF ISSUE DECEMBER, 1995

DRAWING NUMBER **4.4.9**


END OF MEMBRANE WATERPROOFING
SEE PAVEMENT SAW CUT DETAIL.
(See Dwg. No. 4.4.15.)
300 mm
330 mm
BITUMINOUS CONCRETE PAVEMENT
25 mm RADIUS
PROTECTIVE COURSE, SEE NOTE 1.
#13 (TYP.)
25 mm CHAMFER
25 mm Ø FOAM BACKER ROD, SEE NOTE 5.
25 mm
25 mm CLOSED CELL FOAM, SEE NOTE 3.
2% SLOPE
(See Dwg. No. 4.4.15. Note 3.)
50 mm CL. (TYP.)
255 mm
25 mm CHAMFER
1% SLOPE BETWEEN BEARINGS
250 mm
200 mm
50 mm CL
3-#19
(See Dwg. No. 4.4.15 Note 4.)
CONST JT.
#13@300 mm
300 mm
225 mm
225 mm
(See Dwg. No. 4.4.15. Note 2.)
25 mm
℄ BEARINGS
#19@450 mm, 450 mm LONG
(Specify embedment length.)
150 mm

NOTES:

(See Dwg. No. 4.4.14 for notes to be Included on construction plans.)

DETAILS AT ABUTMENT - ROADWAY SECTION

(See Dwg. No. 4.4.11 for Type SIV Beams.)

(Draw to 1:10 scale min.)

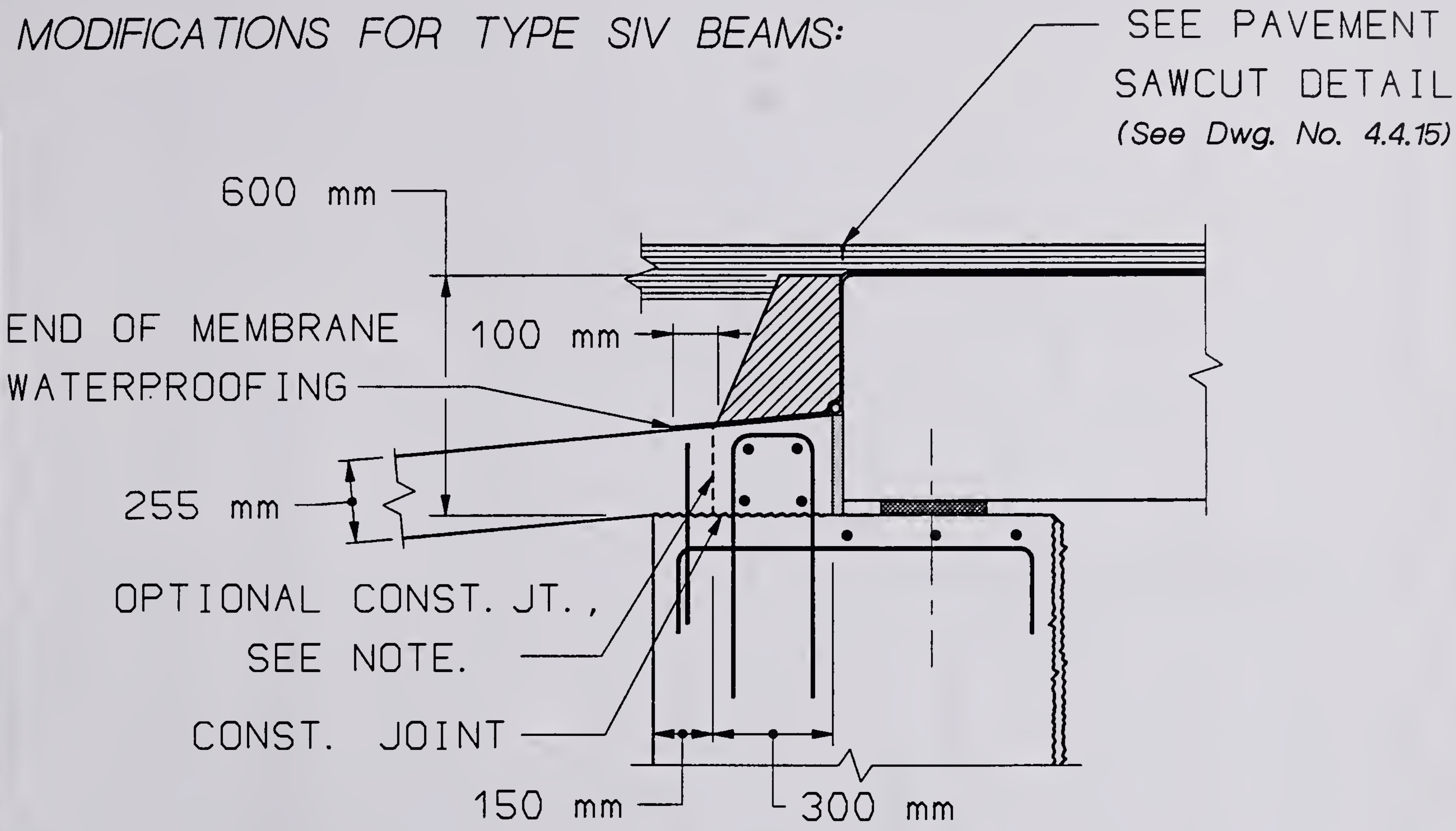
MASSHIGHWAY
BRIDGE
MANUAL

ROADWAY SECTION
TYPE S BEAMS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.10

MODIFICATIONS FOR TYPE SIV BEAMS:


SEE PAVEMENT SAWCUT DETAIL
(See Dwg. No. 4.4.15)
600 mm
END OF MEMBRANE WATERPROOFING
100 mm
255 mm
OPTIONAL CONST. JT., SEE NOTE.
CONST. JOINT
150 mm
300 mm

NOTE:

IF THE APPROACH SLAB IS POURED MONOLITHICALLY WITH THE BACKWALLS, MAKE A 50 mm DEEP BY 3 mm WIDE SAW CUT IN THE TOP OF THE SLAB AT THE OPTIONAL CONSTRUCTION JOINT LOCATION. FILL SAW CUT WITH CONCRETE JOINT SEALER.

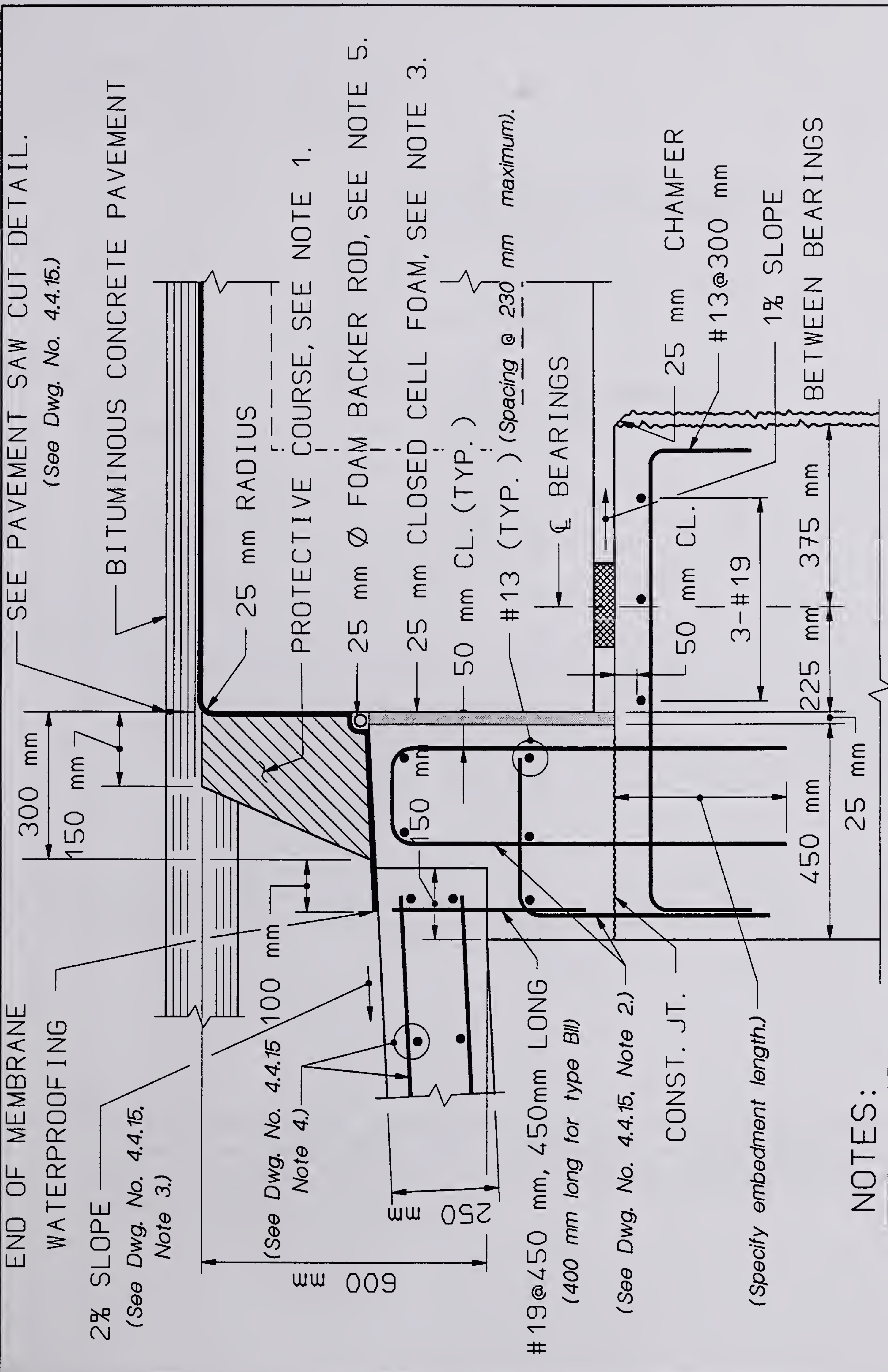
DETAILS AT ABUTMENT - ROADWAY SECTION

(Draw to 1:10 scale min.)

NOTE:

For Type SIV beams, modify Dwg. No. 4.4.10 to the reinforcing and construction joint details shown above and add the construction drawing note above to the construction drawing notes. All other items not detailed or designated above shall be as shown on Dwg. No. 4.4.10.

MASSHIGHWAY BRIDGE MANUAL	ROADWAY SECTION TYPE SIV BEAMS ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.4.11**



NOTES:
(See Dwg. No. 4.4.14 for notes to be included on construction plans.)

DETAILS AT ABUTMENT - ROADWAY SECTION

(See Dwg. No. 4.4.13 for Type BI MOD. and BI beams.)

(Draw to 1:10 scale min.)

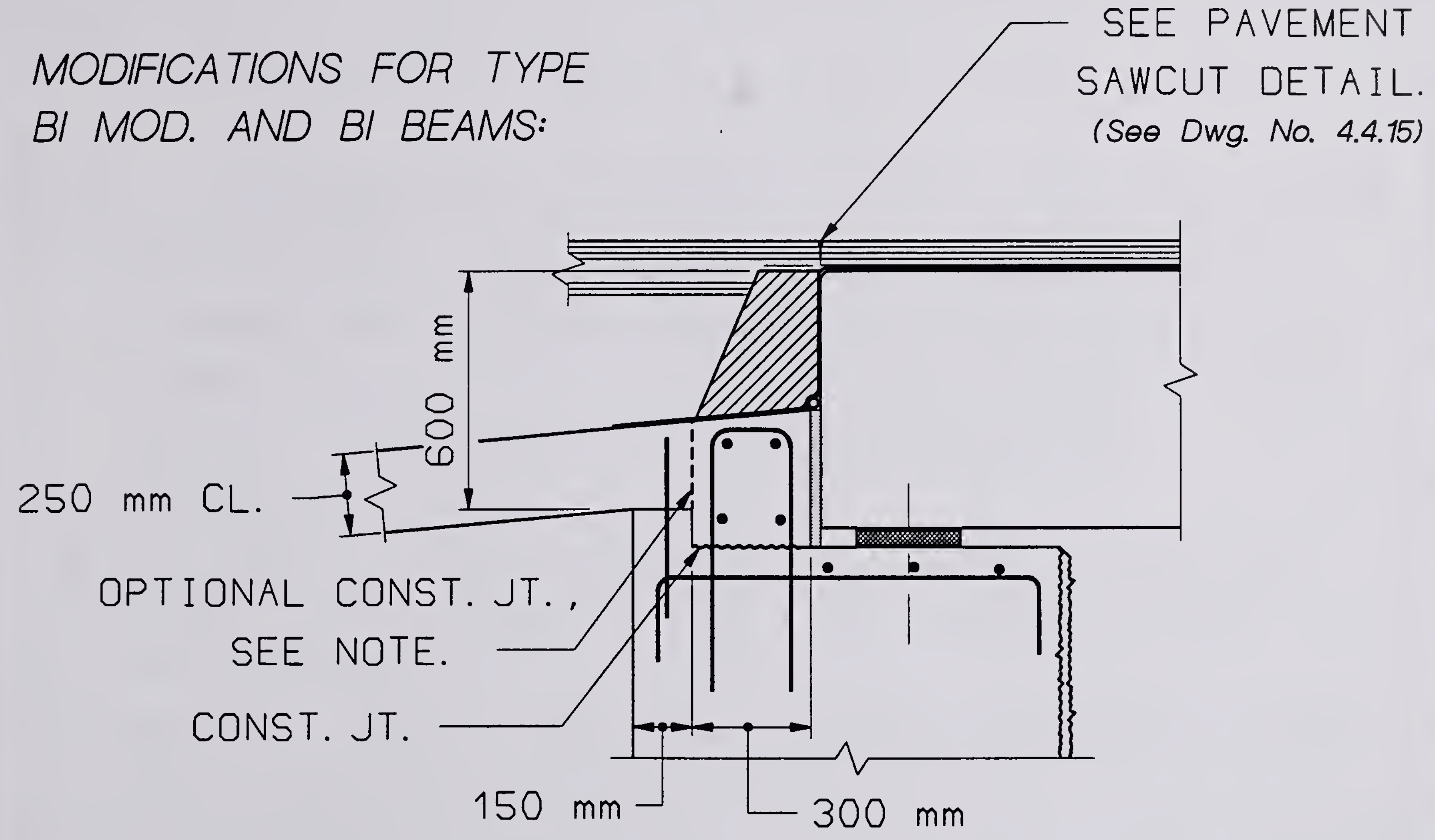
MASS HIGHWAY
BRIDGE
MANUAL

ROADWAY SECTION
TYPE B BEAMS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.12

MODIFICATIONS FOR TYPE BI MOD. AND BI BEAMS:



NOTE:

IF THE APPROACH SLAB IS POURED MONOLITHICALLY WITH THE BACKWALLS, MAKE A 50 mm DEEP BY 3 mm WIDE SAW CUT IN THE TOP OF THE SLAB AT THE OPTIONAL CONSTRUCTION JOINT LOCATION. FILL SAW CUT WITH CONCRETE JOINT SEALER.

DETAILS AT ABUTMENT - ROADWAY SECTION

(Draw to 1:10 scale min.)

NOTE:

For Type BI MOD. and BI beams, modify Dwg. No. 4.4.12 to the reinforcing and construction joint details shown above and add the construction drawing note above to the construction drawing notes. All other items not detailed or designated above shall be as shown on Dwg. No. 4.4.12.

MASS HIGHWAY
BRIDGE MANUAL

ROADWAY SECTION
TYPE BI MOD. & BI BEAMS
ABUTMENT DETAILS

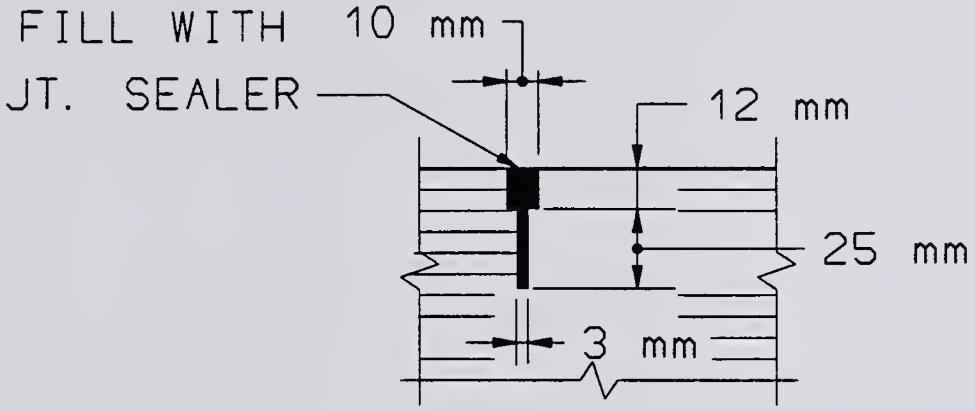
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.13

NOTES: *(Include these notes with detail shown on Dwg. No. 4.4.10, 4.4.12, and 4.4.16.)*

1. PROTECTIVE COURSE TO BE CLASS I DENSE BINDER COURSE FOR BRIDGES, PLACED IN 50 mm LAYERS AND COMPACTED WITH A MECHANICAL HAND-GUIDED TAMPER WITHIN 12 HOURS AFTER PLACING MEMBRANE WATERPROOFING.
2. ALL REINFORCING SHOWN IN THIS DETAIL SHALL BE EPOXY COATED BARS, EXCEPT FOR APPROACH SLAB REINFORCEMENT.
3. ATTACH CLOSED CELL FOAM TO BACK OF PRECAST BEAM WITH ADHESIVE.
4. ALL CONCRETE ABOVE THE CONSTRUCTION JOINT LOCATED AT THE BRIDGE SEAT SHALL BE 30 MPa, 20 mm, 390 kg CEMENT CONCRETE MASONRY AND SHALL BE PLACED AFTER ALL BEAMS HAVE BEEN ERECTED. THE CONCRETE BELOW THE BACKWALL AT THE CONSTRUCTION JOINT SHALL BE FINISHED WITH A ROUGHENED SURFACE OF 6 mm AMPLITUDE.
5. DRAPE MEMBRANE WATERPROOFING OVER CLOSED CELL FOAM BACKER ROD.

MASS HIGHWAY BRIDGE MANUAL	CONSTRUCTION NOTES FOR DETAILS @ ABUTMENT ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.4.14**



PAVEMENT SAWCUT DETAIL

NOT TO SCALE

NOTES:

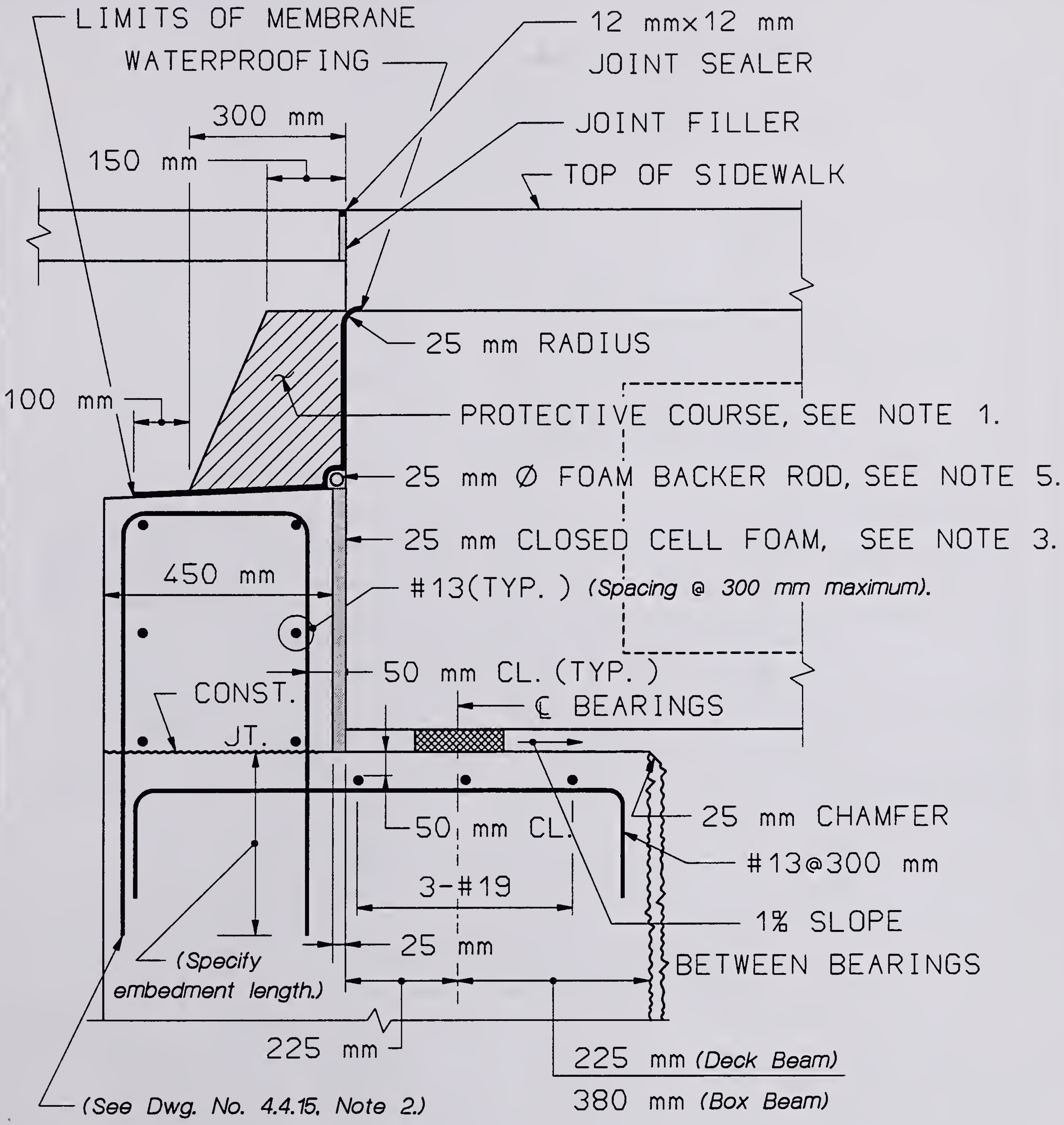
1. *Designer notes listed here are for the details of the abutment at roadway sections. Dwg. No's. 4.4.10 and 4.4.12.*
2. *Backwall reinforcement extending into the top of the abutment shall be designed to resist longitudinal seismic loads. (At a minimum, provide #16 @300 mm.)*
3. *If approach roadway up-grade is greater than 2%, change slope of approach slab to approach roadway grade plus 1%.*
4. *Label approach slab reinforcement bar size and spacing on Detail at Abutment - Roadway Section, also show extent of bituminous damp-proofing. For details See Dwg. No. 3.1.12.*

MASS HIGHWAY
BRIDGE MANUAL

PAVEMENT SAWCUT DETAIL &
DESIGNER NOTES
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.4.15


LIMITS OF MEMBRANE WATERPROOFING
12 mm×12 mm JOINT SEALER
JOINT FILLER
TOP OF SIDEWALK
300 mm
150 mm
25 mm RADIUS
100 mm
PROTECTIVE COURSE, SEE NOTE 1.
25 mm Ø FOAM BACKER ROD, SEE NOTE 5.
25 mm CLOSED CELL FOAM, SEE NOTE 3.
450 mm
#13(TYP.) (Spacing @ 300 mm maximum).
50 mm CL. (TYP.)
CONST. JT.
℄ BEARINGS
50 mm CL.
25 mm CHAMFER
#13@300 mm
3-#19
1% SLOPE BETWEEN BEARINGS
25 mm
(Specify embedment length.)
225 mm
225 mm (Deck Beam)
380 mm (Box Beam)
(See Dwg. No. 4.4.15, Note 2.)

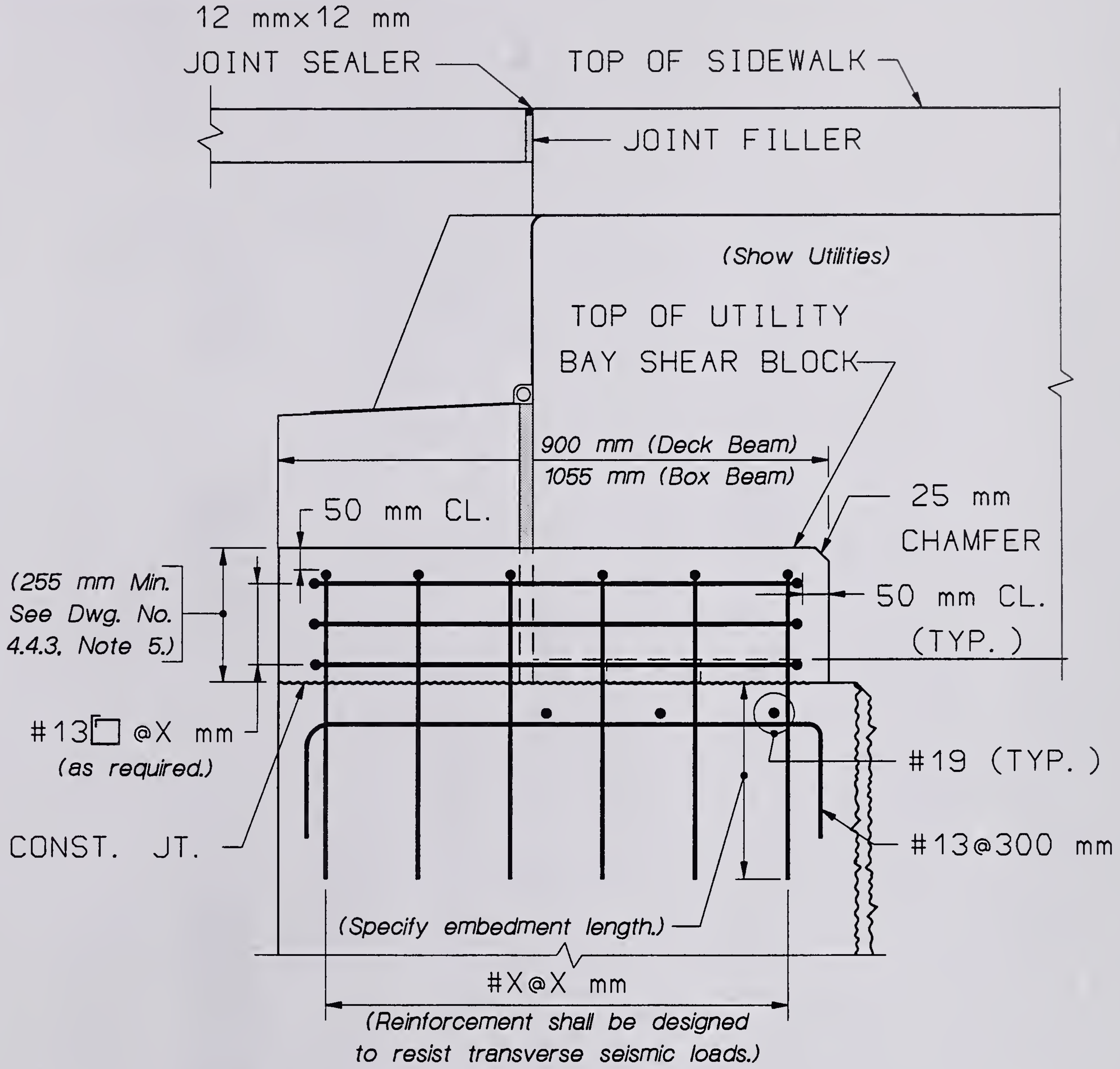
NOTES:

(See Dwg. No. 4.4.14 for notes to be included on construction plans, modify as necessary.)

DETAILS AT ABUTMENT-SIDEWALK SECTION

(Draw to 1:10 scale min.)

MASS HIGHWAY BRIDGE MANUAL	SIDEWALK SECTION ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.4.16**



NOTES:

1. BRICK-UP AROUND UTILITIES AFTER BEAMS ARE IN PLACE AND AFTER THE BACKWALL AND THE UTILITY BAY SHEAR BLOCK HAVE BEEN CONSTRUCTED.

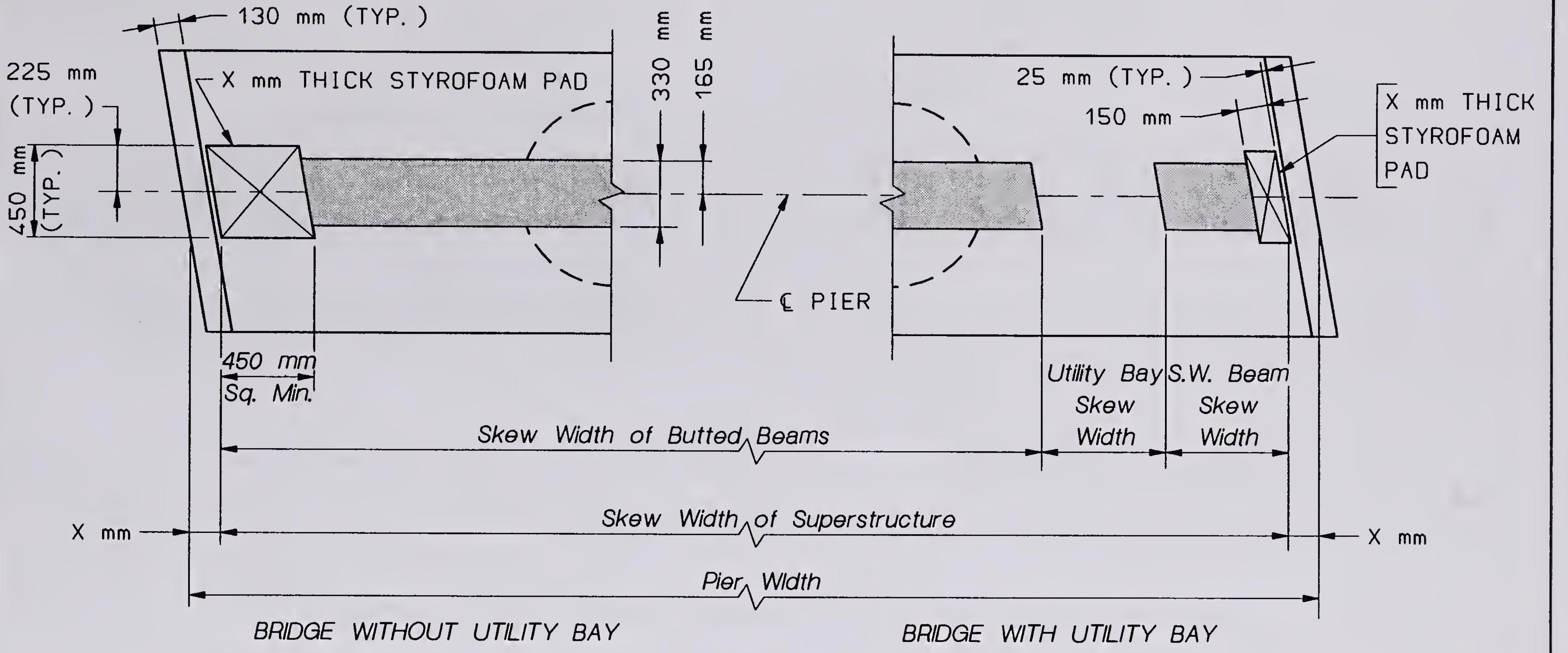
(Include Notes 2 and 4 from Dwg. No. 4.4.14.)

DETAILS AT ABUTMENT

UTILITY BAY SECTION

(Draw to 1:10 scale min.)

MASS HIGHWAY BRIDGE MANUAL	UTILITY BAY SECTION ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.4.17**



NOTES:

1. ▨ DENOTES LIMITS OF 280 mm DEEP BY 330 mm WIDE SHEAR KEY.
2. ALL SURFACES OF THE SHEAR KEY SHALL BE LINED WITH 12 mm THICK CLOSED CELL FOAM.
3. PROVIDE ADDITIONAL STYROFOAM AS SHOWN IN "DETAILS OVER PIER".

PLAN OF PIER *(BEAM CONTINUITY @ PIER)*

SCALE (1:50 *min.*)

NOTES:

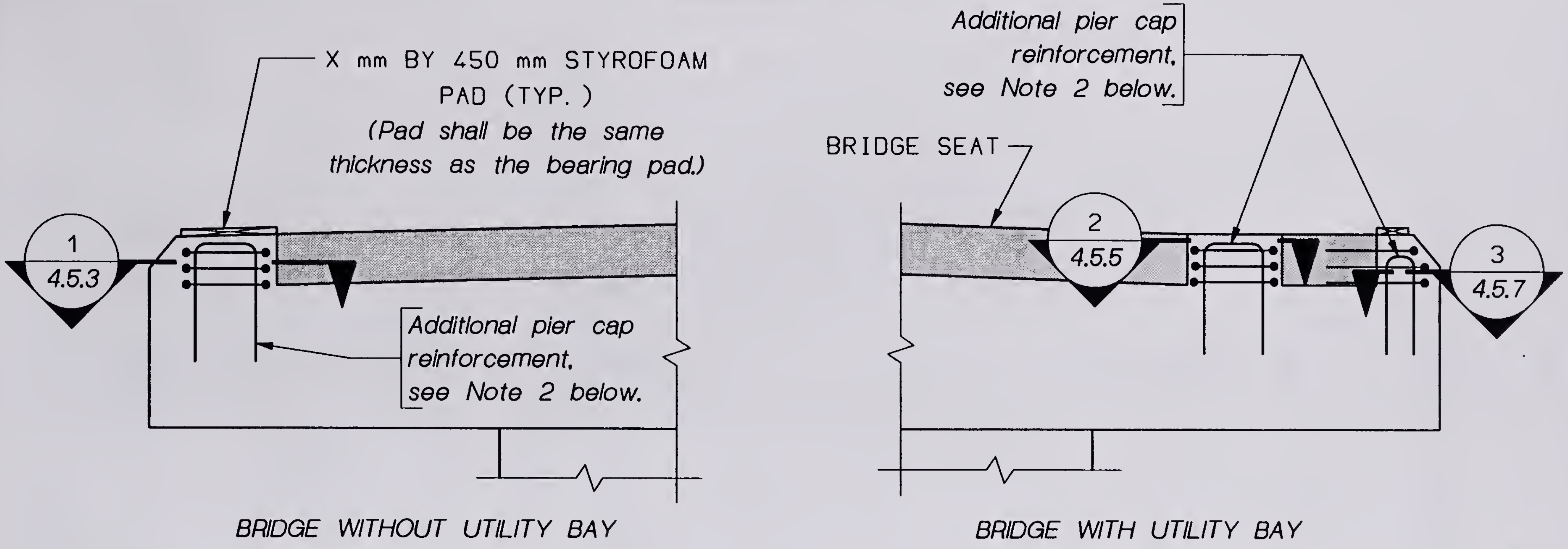
1. *Above drawing is not drawn to scale.*
2. *Remainder of pier has been omitted for clarity.*
3. *Plan of pier shall be drawn without breaks and to scale on the construction plans. Include all relevant dimensions, angles, survey information and north arrow.*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL PLAN
FOR BEAM CONTINUITY
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.1



BRIDGE WITHOUT UTILITY BAY

BRIDGE WITH UTILITY BAY

NOTES:

1. ▨ DENOTES LIMITS OF 280 mm DEEP BY 330 mm WIDE SHEAR KEY.
2. ALL SURFACES OF THE SHEAR KEY SHALL BE LINED WITH 12 mm THICK CLOSED CELL FOAM JOINT FILLER.

TRANSVERSE SECTION OF PIER *(FOR BEAM CONT. @ PIER)*

SCALE (1:50 *min.*)

NOTES:

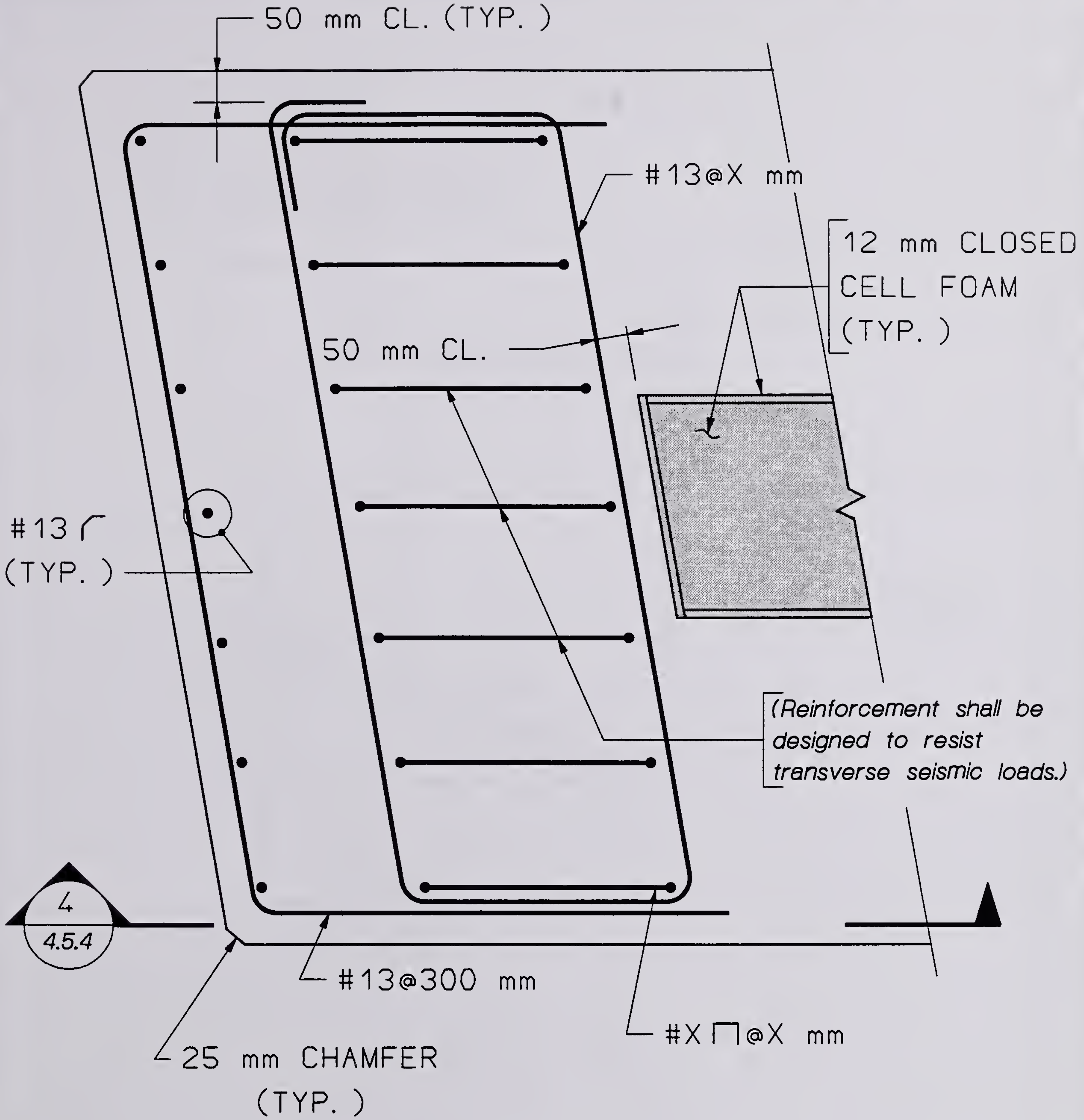
1. *Above drawing is not drawn to scale.*
2. *Additional pier cap reinforcement for transverse restraint shall be designed as a connection for seismic forces.*
3. *Remainder of pier and reinforcement omitted for clarity.*
4. *The transverse section shall be drawn without breaks and to scale on the construction plans and all reinforcement shall be included.*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL TRANSVERSE SECTION
FOR BEAM CONTINUITY
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.2


50 mm CL. (TYP.)
#13@X mm
12 mm CLOSED CELL FOAM (TYP.)
50 mm CL.
(Reinforcement shall be designed to resist transverse seismic loads.)
#13 ⌐ (TYP.)
4
4.5.4
#13@300 mm
#X ⊓@X mm
25 mm CHAMFER (TYP.)

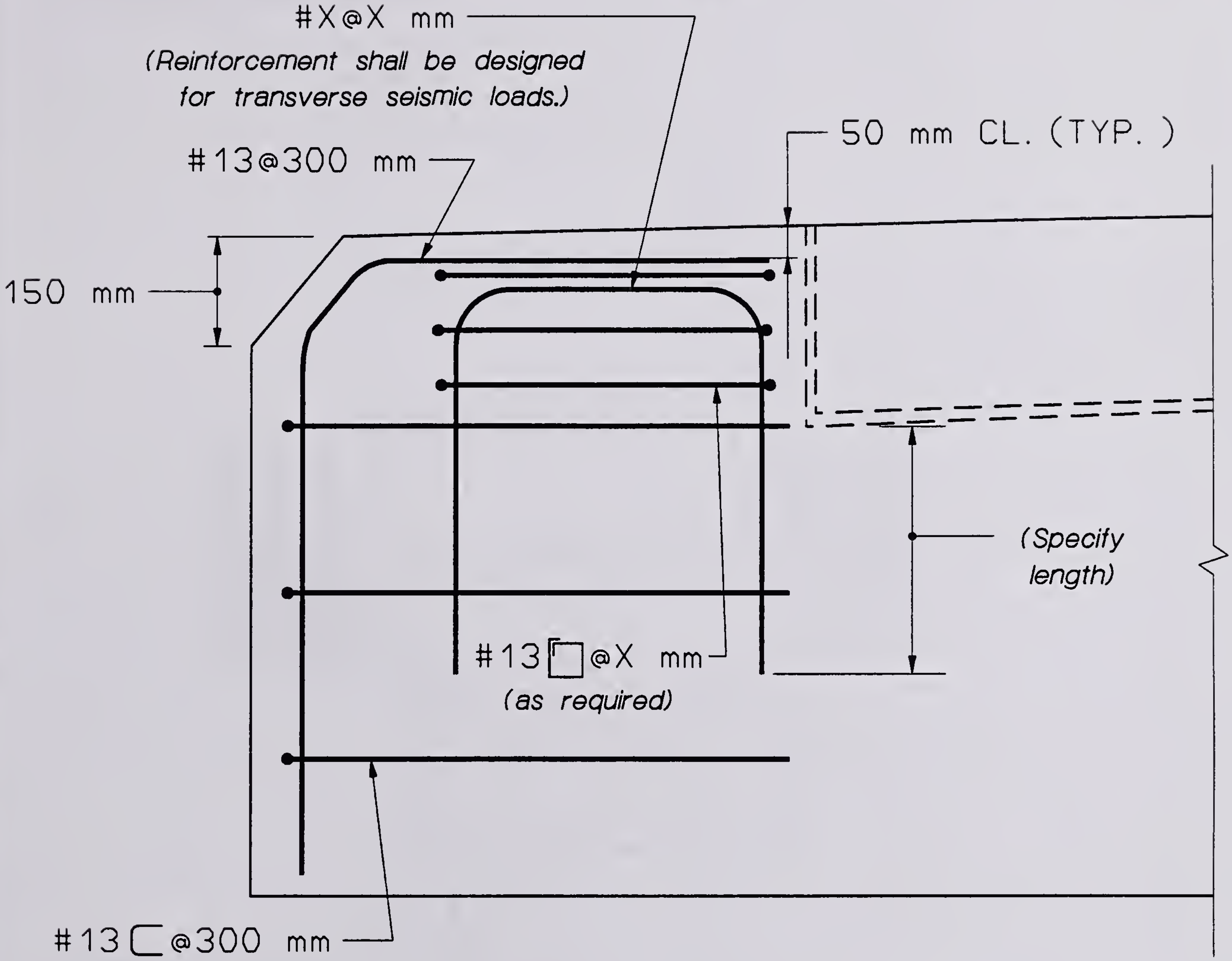
SECTION 1

SCALE 1:10

NOTES:

1. *Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.*
2. *The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.*

MASS HIGHWAY BRIDGE MANUAL	PLAN SECT. @ PIER END (W/O UTIL. BAY) FOR BEAM CONTIN. PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.5.3



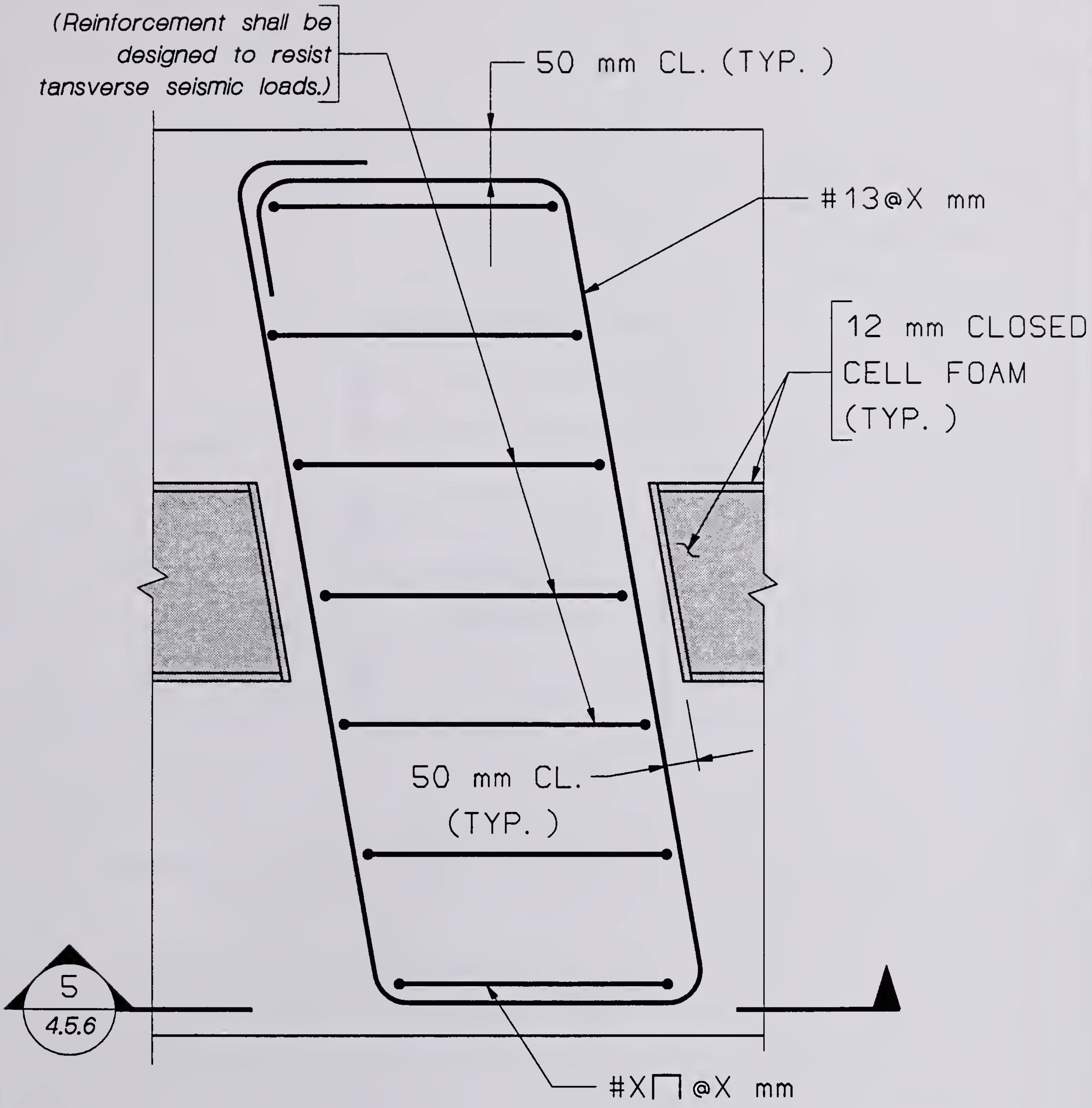
SECTION 4

SCALE 1: 10

NOTES:

1. Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.
2. The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.

MASS HIGHWAY BRIDGE MANUAL	VERT. SECT. @ PIER END (W/O UTIL. BAY) FOR BEAM CONTIN. PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.5.4


(Reinforcement shall be designed to resist tansverse seismic loads.)
50 mm CL. (TYP.)
#13@X mm
12 mm CLOSED CELL FOAM (TYP.)
50 mm CL. (TYP.)
5
4.5.6
#X⊓@X mm

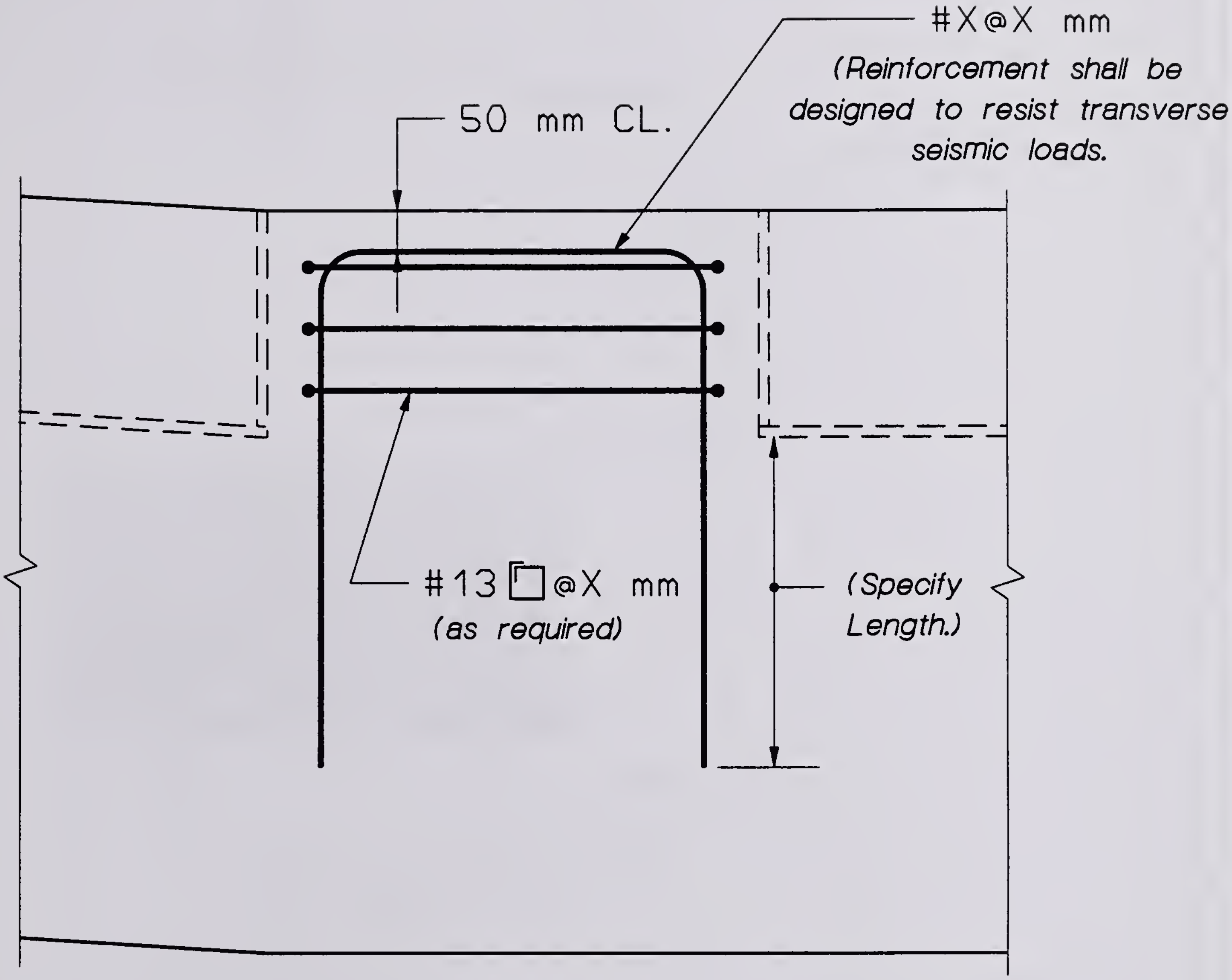
SECTION 2

SCALE 1: 10

NOTES:

1. *Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.*
2. *The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.*

MASS HIGHWAY BRIDGE MANUAL	PLAN SECTION @ UTILITY BAY FOR BEAM CONTINUITY PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.5.5**


#X@X mm
(Reinforcement shall be designed to resist transverse seismic loads.
50 mm CL.
#13 ⊏@X mm
(as required)
(Specify Length.)

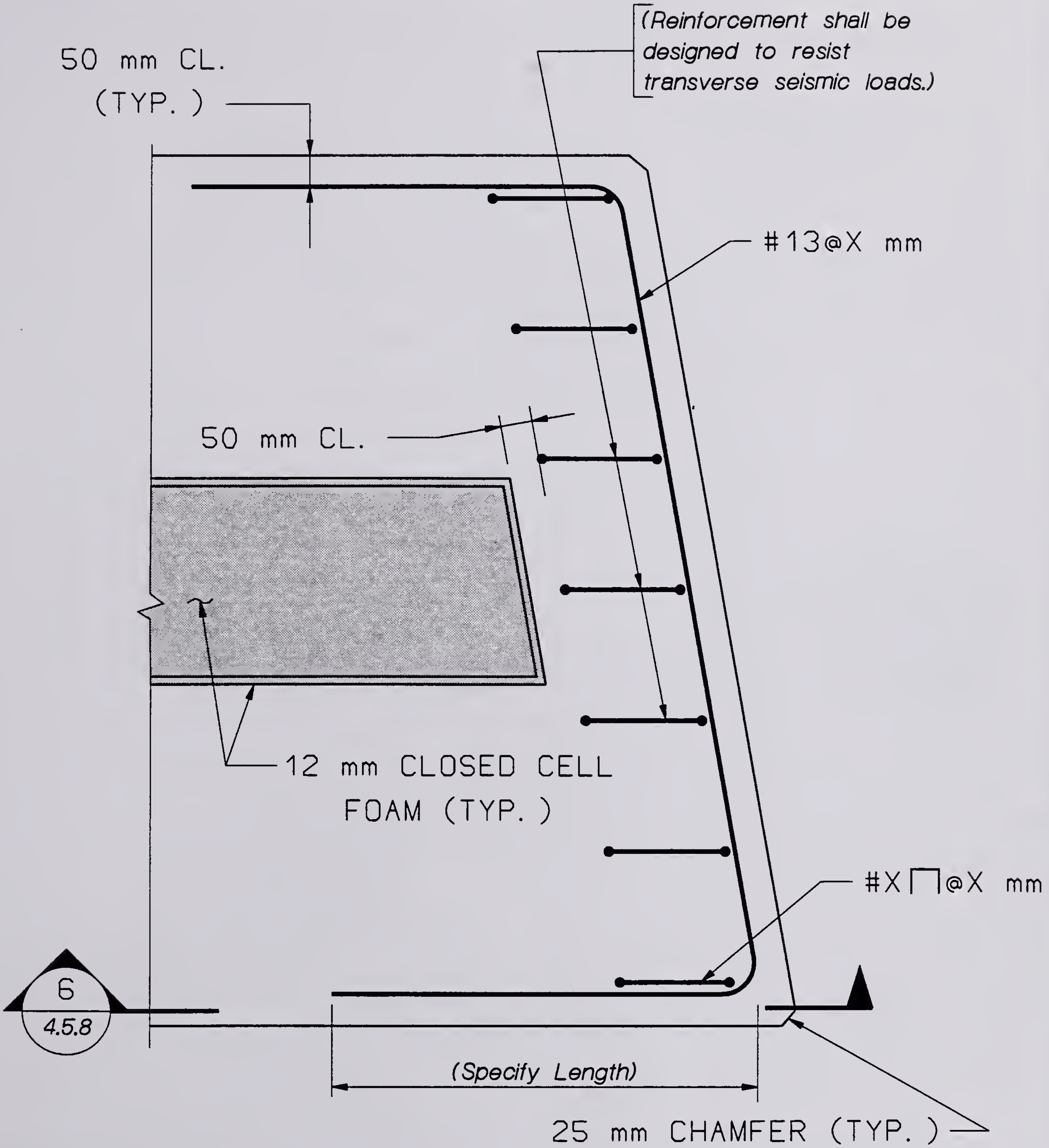
SECTION 5

SCALE 1: 10

NOTES:

1. Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.
2. The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.

MASS HIGHWAY BRIDGE MANUAL	VERT. SECTION @ UTILITY BAY FOR BEAM CONTINUITY PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER 4.5.6


(Reinforcement shall be designed to resist transverse seismic loads.)
50 mm CL. (TYP.)
#13@X mm
50 mm CL.
12 mm CLOSED CELL FOAM (TYP.)
#X ⊓@X mm
6
4.5.8
(Specify Length)
25 mm CHAMFER (TYP.)

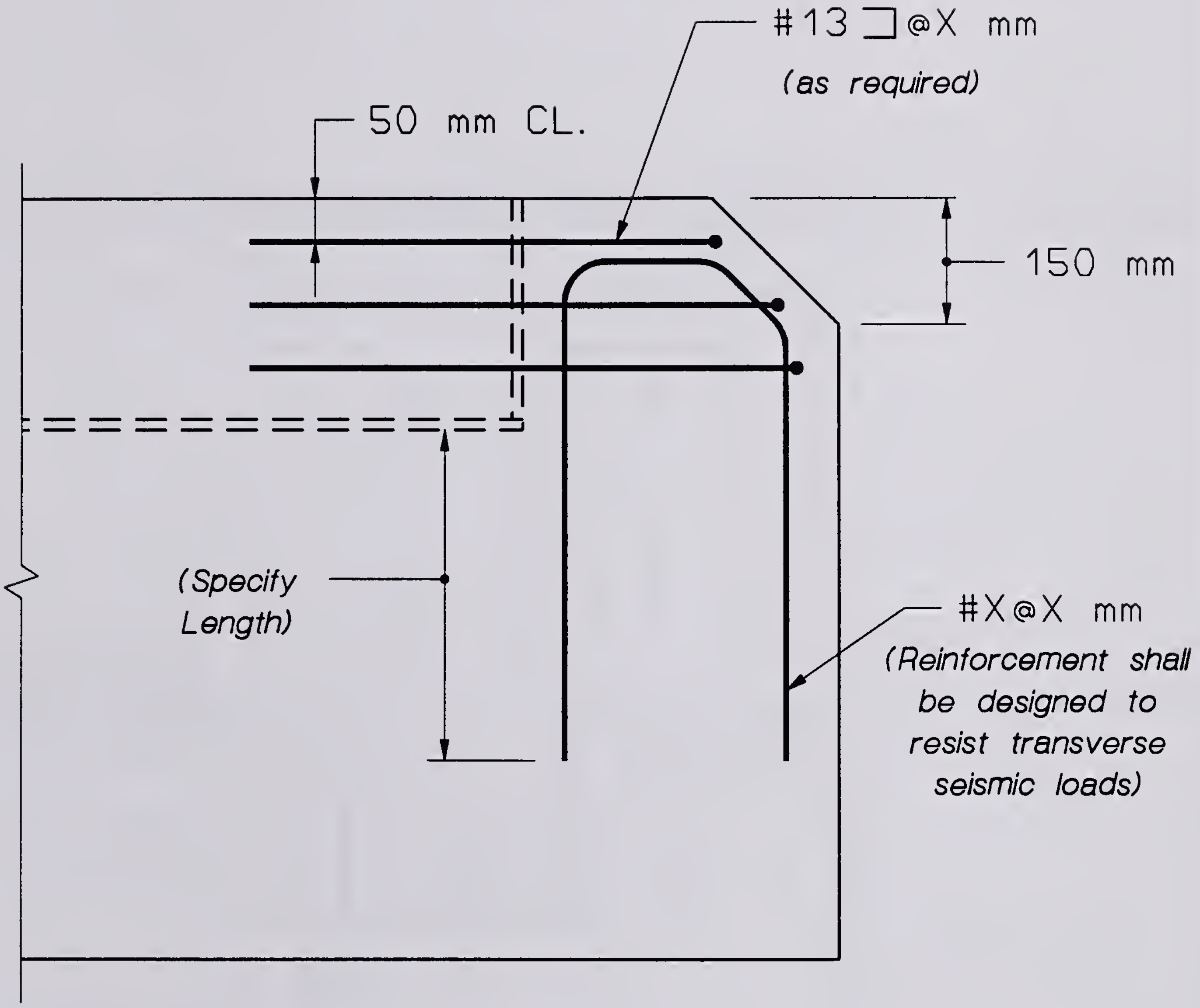
SECTION 3

SCALE 1:10

NOTES:

1. *Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.*
2. *The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.*

MASS HIGHWAY BRIDGE MANUAL	PLAN SECT. @ PIER END (W/ UTIL. BAY) FOR BEAM CONTIN. PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.5.7**


#13 ⊐@X mm
(as required)
50 mm CL.
150 mm
(Specify Length)
#X@X mm
(Reinforcement shall be designed to resist transverse seismic loads)

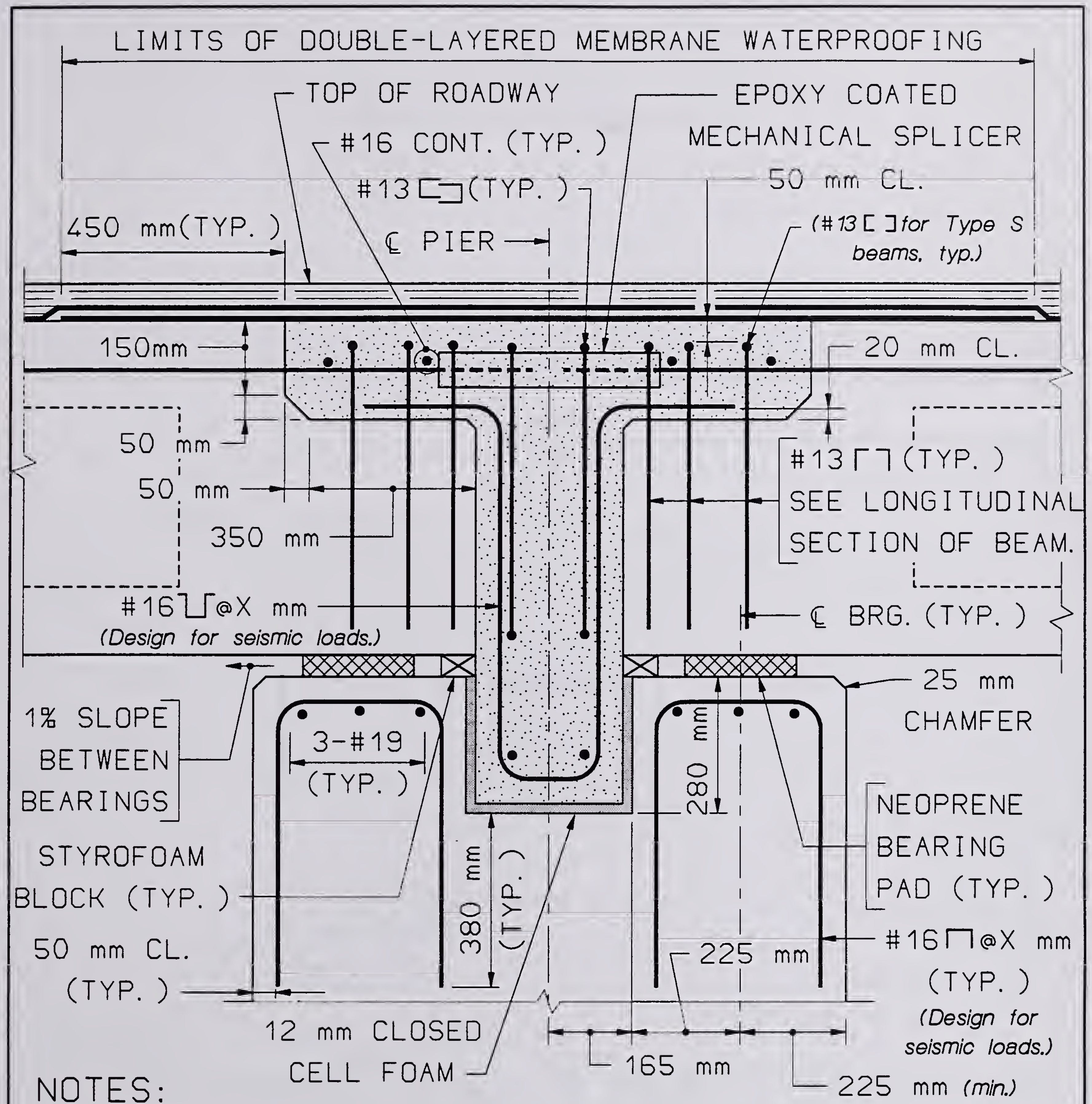
SECTION 6

SCALE 1:10

NOTES:

1. Only the end reinforcement is shown above. All other pier reinforcement has been omitted for clarity.
2. The designer shall verify that the reinforcement shown does not interfere with or duplicate the normal pier reinforcement and adjust as necessary.

MASS HIGHWAY BRIDGE MANUAL	VERT. SECT. @ PIER END (W/ UTIL. BAY) FOR BEAM CONTIN. PIER DETIALS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **4.5.8**


LIMITS OF DOUBLE-LAYERED MEMBRANE WATERPROOFING
TOP OF ROADWAY
#16 CONT. (TYP.)
#13 ⊏⊐ (TYP.)
℄ PIER
EPOXY COATED MECHANICAL SPLICER
50 mm CL.
(#13 [ ] for Type S beams, typ.)
450 mm (TYP.)
150mm
20 mm CL.
50 mm
50 mm
350 mm
#13 ┌┐ (TYP.) SEE LONGITUDINAL SECTION OF BEAM.
#16 └┘ @X mm (Design for seismic loads.)
℄ BRG. (TYP.)
1% SLOPE BETWEEN BEARINGS
3-#19 (TYP.)
25 mm CHAMFER
280 mm
NEOPRENE BEARING PAD (TYP.)
STYROFOAM BLOCK (TYP.)
380 mm (TYP.)
50 mm CL. (TYP.)
225 mm
#16 ┌┐ @X mm (TYP.) (Design for seismic loads.)
12 mm CLOSED CELL FOAM
165 mm
225 mm (min.)

NOTES:

1. ▒ DENOTES LIMITS OF 35 MPa, 20 mm, 375 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.
2. REMAINDER OF REINFORCEMENT HAS BEEN OMITTED FOR CLARITY.

DETAILS OVER PIER

(Draw to 1:10 scale min.)

(See Dwg. No. 4.5.10 for Type SI & SII beams.)

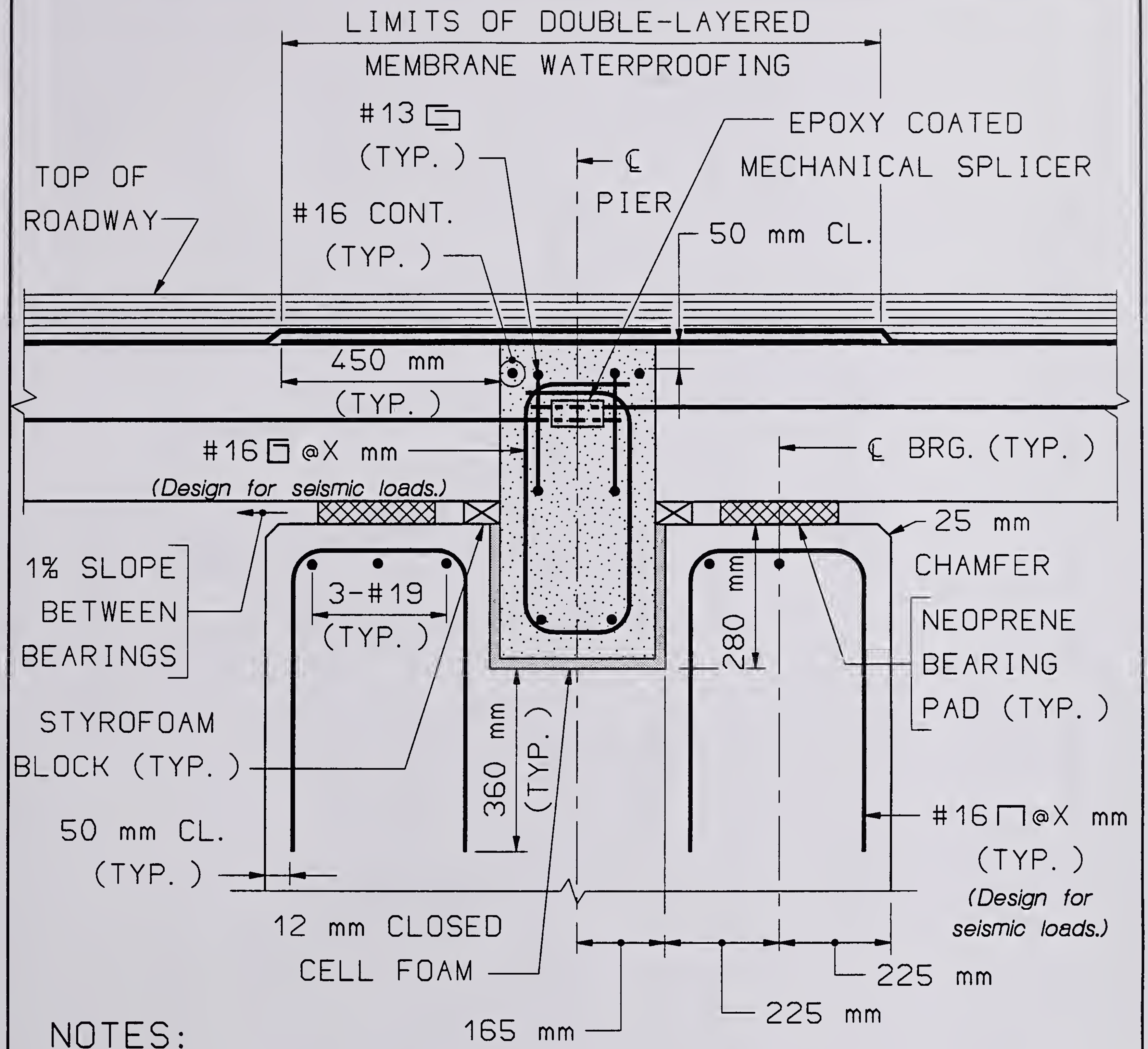
NOTE: Do not extend prestressed strands into closure pour.

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL ROADWAY SECTION
FOR BEAM CONTINUITY
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.9



NOTES:

1. ▨ DENOTES LIMITS OF 35 MPa, 20 mm, 385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.
2. REMAINDER OF REINFORCEMENT HAS BEEN OMITTED FOR CLARITY.

DETAILS OVER PIER

(Draw to 1:10 scale min.)

(Type SI & SII beams. See Dwg. No. 4.5.9 for other beams.)

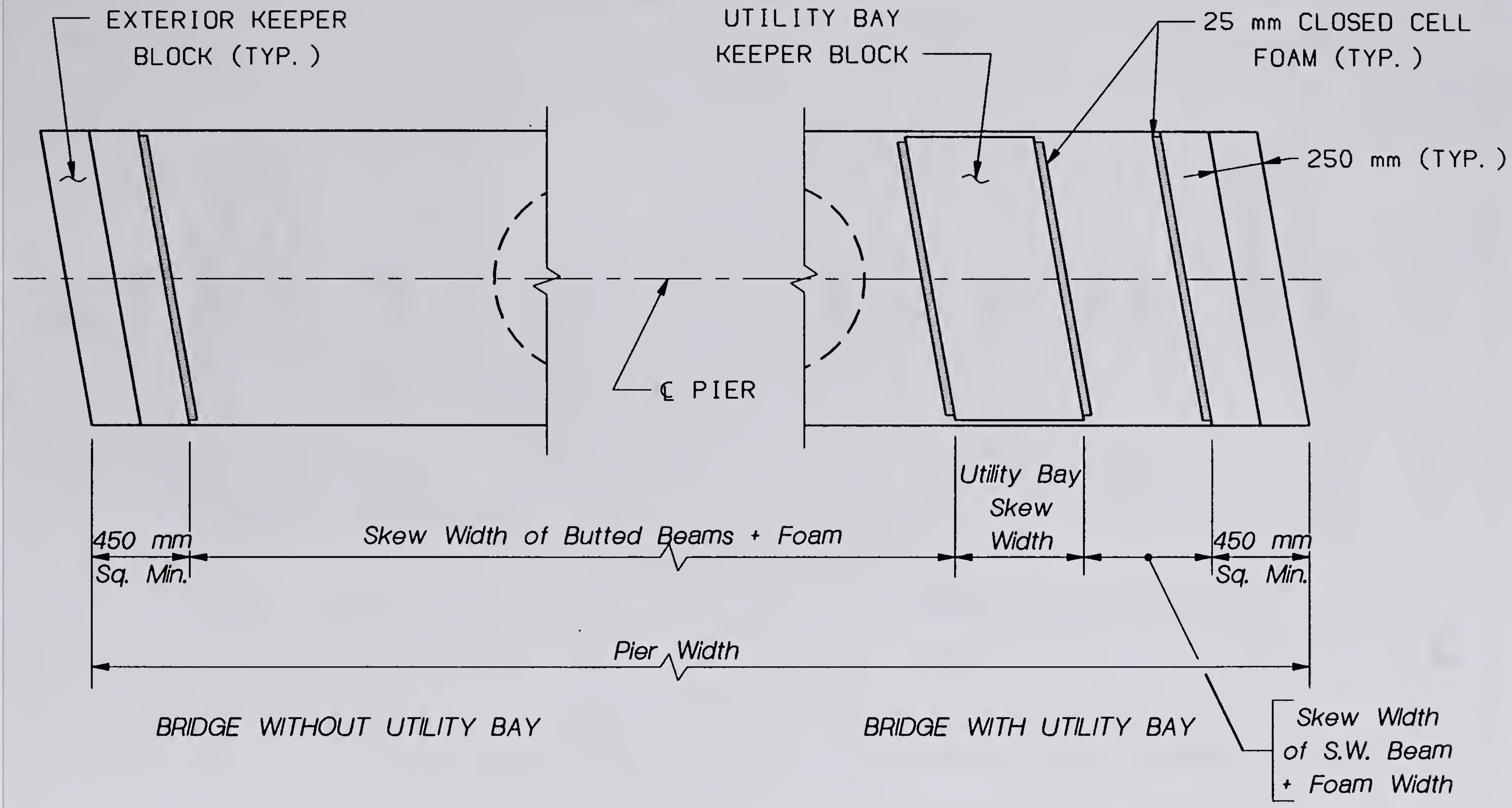
NOTE:
Do not extend prestressed strands into closure pour.

MASSHIGHWAY
BRIDGE MANUAL

ROADWAY SECTION (SI & SII ONLY) FOR BEAM CONTINUITY
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.10


EXTERIOR KEEPER BLOCK (TYP.)
UTILITY BAY KEEPER BLOCK
25 mm CLOSED CELL FOAM (TYP.)
250 mm (TYP.)
℄ PIER
450 mm Sq. Min.
Skew Width of Butted Beams + Foam
Utility Bay Skew Width
450 mm Sq. Min.
Pier Width
BRIDGE WITHOUT UTILITY BAY
BRIDGE WITH UTILITY BAY
Skew Width of S.W. Beam + Foam Width

PLAN OF PIER (JOINT @ PIER)

SCALE (1:50 min.)

NOTES:

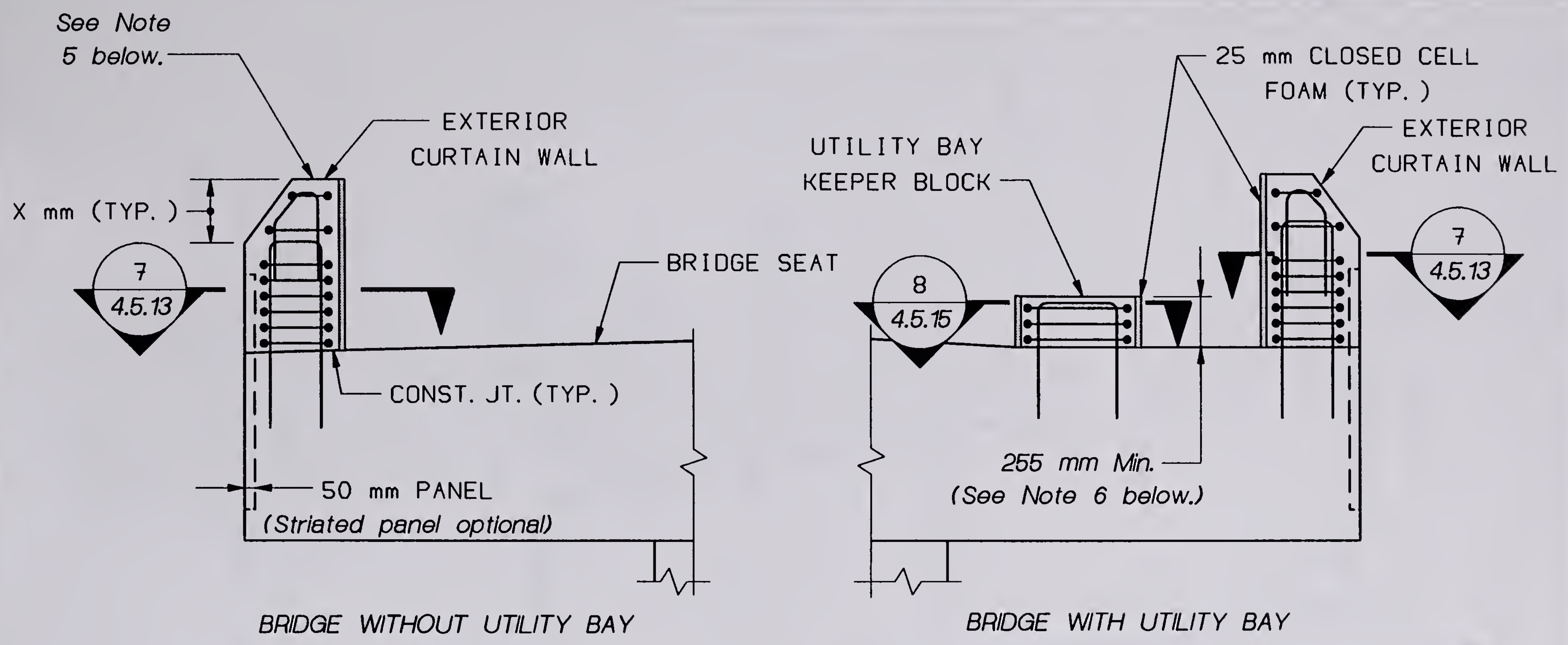
1. Above drawing is not drawn to scale.
2. Remainder of pier has been omitted for clarity.
3. Plan of pier shall be drawn without breaks and to scale on the construction plans. Include all relevant dimensions, angles, survey information and north arrow.

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL PLAN
JOINT AT PIER
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.11



TRANSVERSE SECTION OF PIER *(JOINT @ PIER)*

SCALE (1:50 *min.*)

NOTES:

1. *Above detail is not drawn to scale.*
2. *Only the pier cap reinforcement for transverse restraint is shown. This reinforcement shall be designed as a connection for seismic forces.*
3. *Remainder of pier and reinforcement omitted for clarity.*
4. *Transverse section shall be drawn without breaks and to scale on the construction plans. All reinforcement shall be indicated and all relevant elevations and dimensions shall be included.*
5. *The top of the exterior shear blocks should extend to the top of the beam, sidewalk, or curb.*
6. *If the 255 mm minimum height of the utility bay keeper block interferes with the placement of the utilities, the designer shall design an alternate method to brace the beams laterally for seismic loads.*

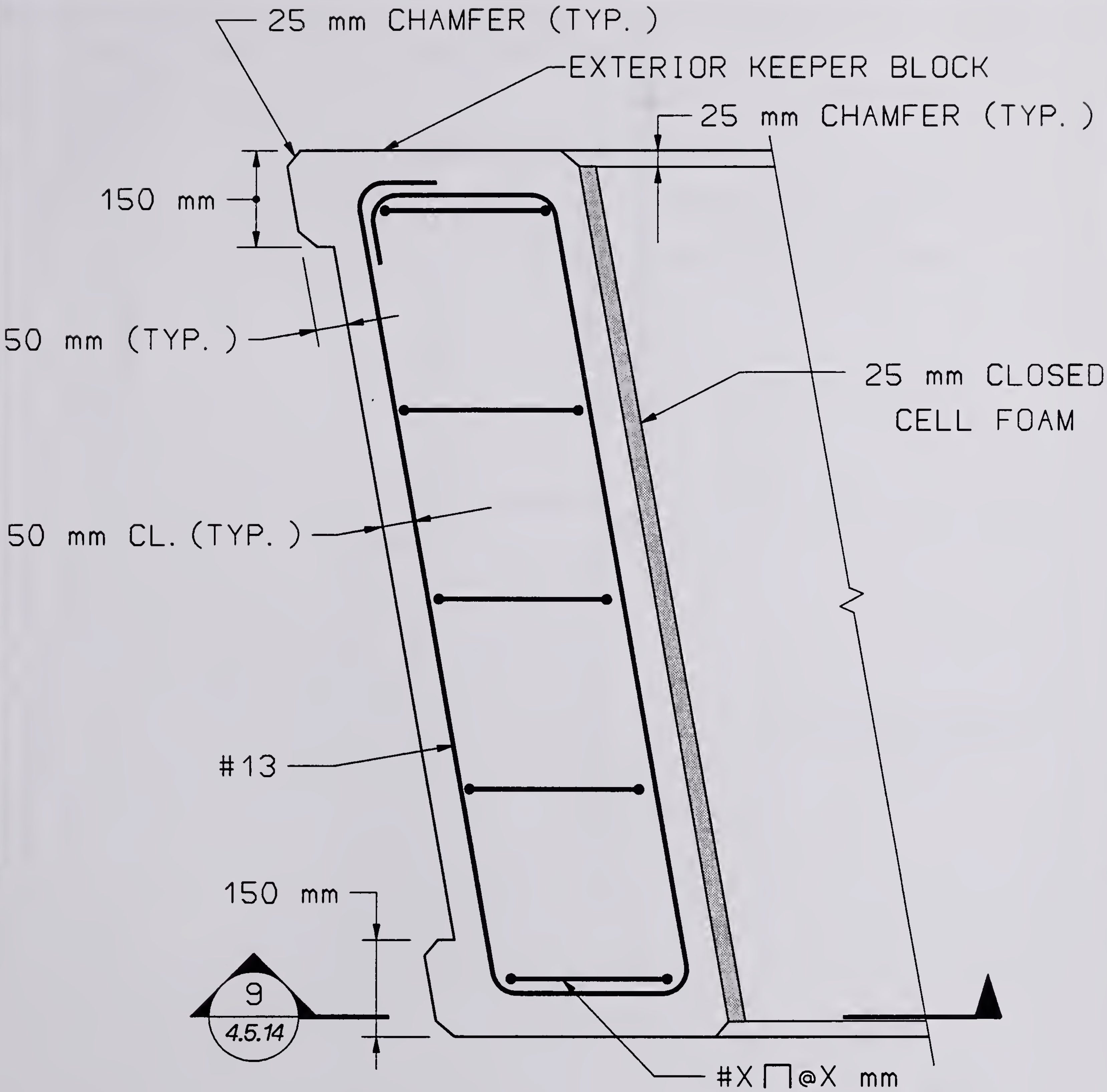
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL TRANSVERSE SECTION FOR JOINT AT PIER

PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.12



(Reinforcement shall be designed to resist transverse seismic loads.)

NOTE:

ATTACH THE CLOSED CELL FOAM TO THE SIDE OF THE EXTERIOR PRECAST BEAMS PRIOR TO PLACING THE CONCRETE FOR THE EXTERIOR KEEPER BLOCK.

SECTION 7

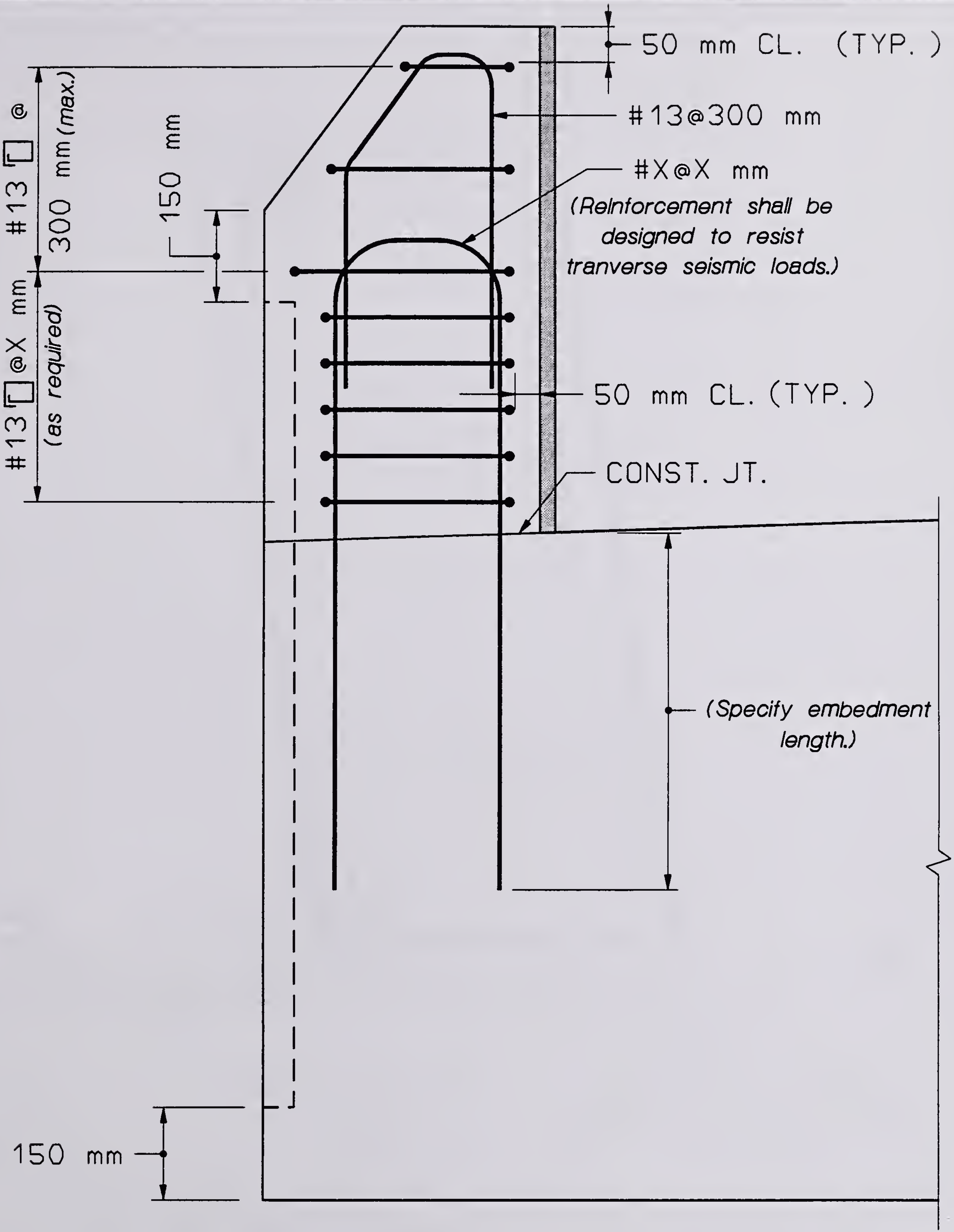
SCALE 1: 10

MASS HIGHWAY
BRIDGE
MANUAL

PLAN SECTION @ PIER END
FOR JOINT AT PIER
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.13


50 mm CL. (TYP.)
#13@300 mm
#X@X mm
(Reinforcement shall be designed to resist tranverse seismic loads.)
#13 ⌐ @ 300 mm (max.)
150 mm
#13 ⌐ @X mm (as required)
50 mm CL. (TYP.)
CONST. JT.
(Specify embedment length.)
150 mm

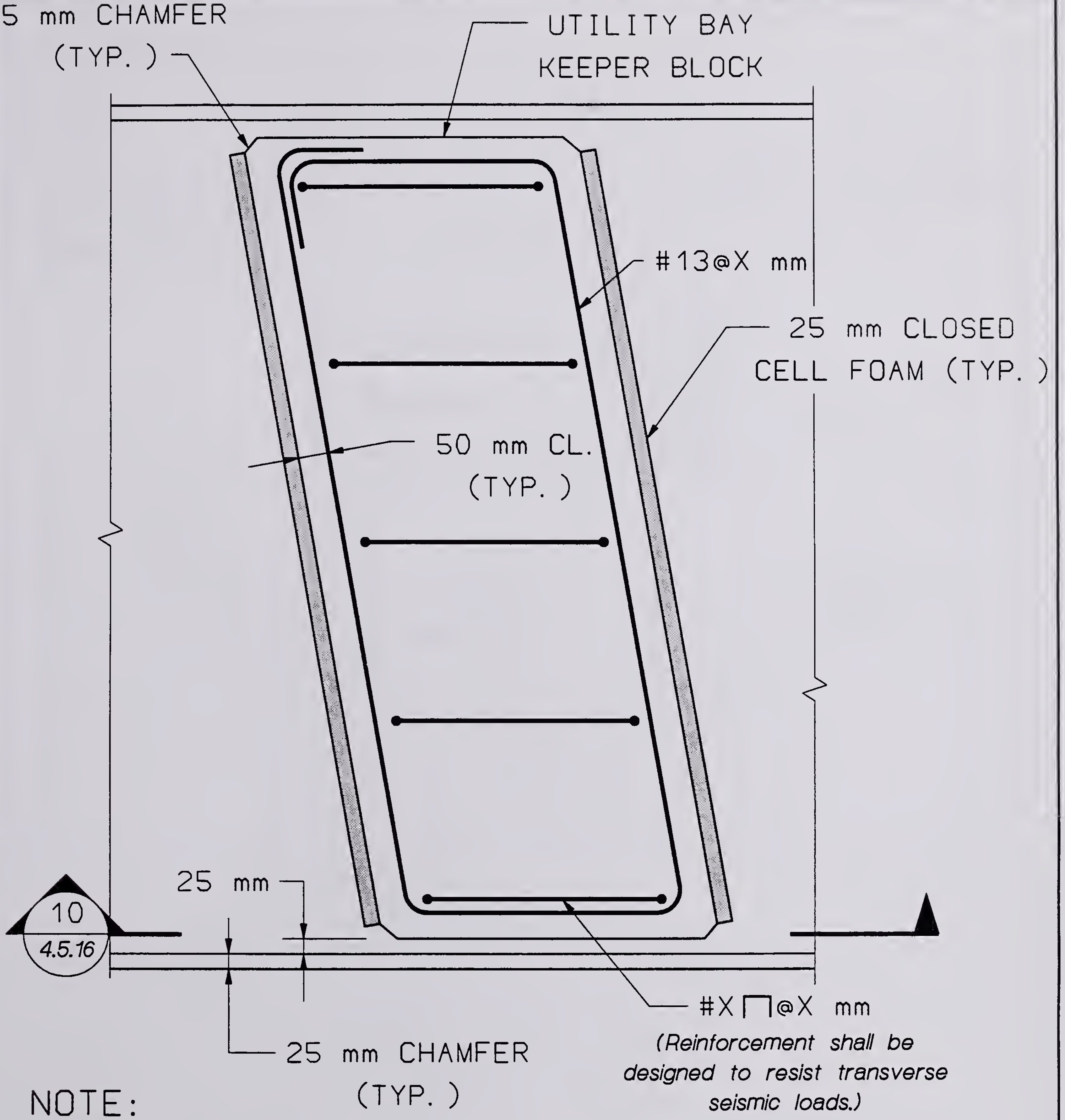
SECTION 9

SCALE 1:10

NOTES:

1. *Only the transverse seismic reinforcement is shown above. All other pier reinforcement has been omitted for clarity.*
2. *The designer shall verify that the above reinforcement does not interfere with the normal pier reinforcement and modify as necessary.*

MASS HIGHWAY BRIDGE MANUAL	VERT. SECTION @ PIER END FOR JOINT AT PIER PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.5.14**



(Reinforcement shall be designed to resist transverse seismic loads.)

NOTE:

ATTACH THE CLOSED CELL FOAM TO THE SIDE OF THE EXTERIOR PRECAST BEAMS PRIOR TO PLACING THE CONCRETE FOR THE UTILITY BAY KEEPER BLOCK.

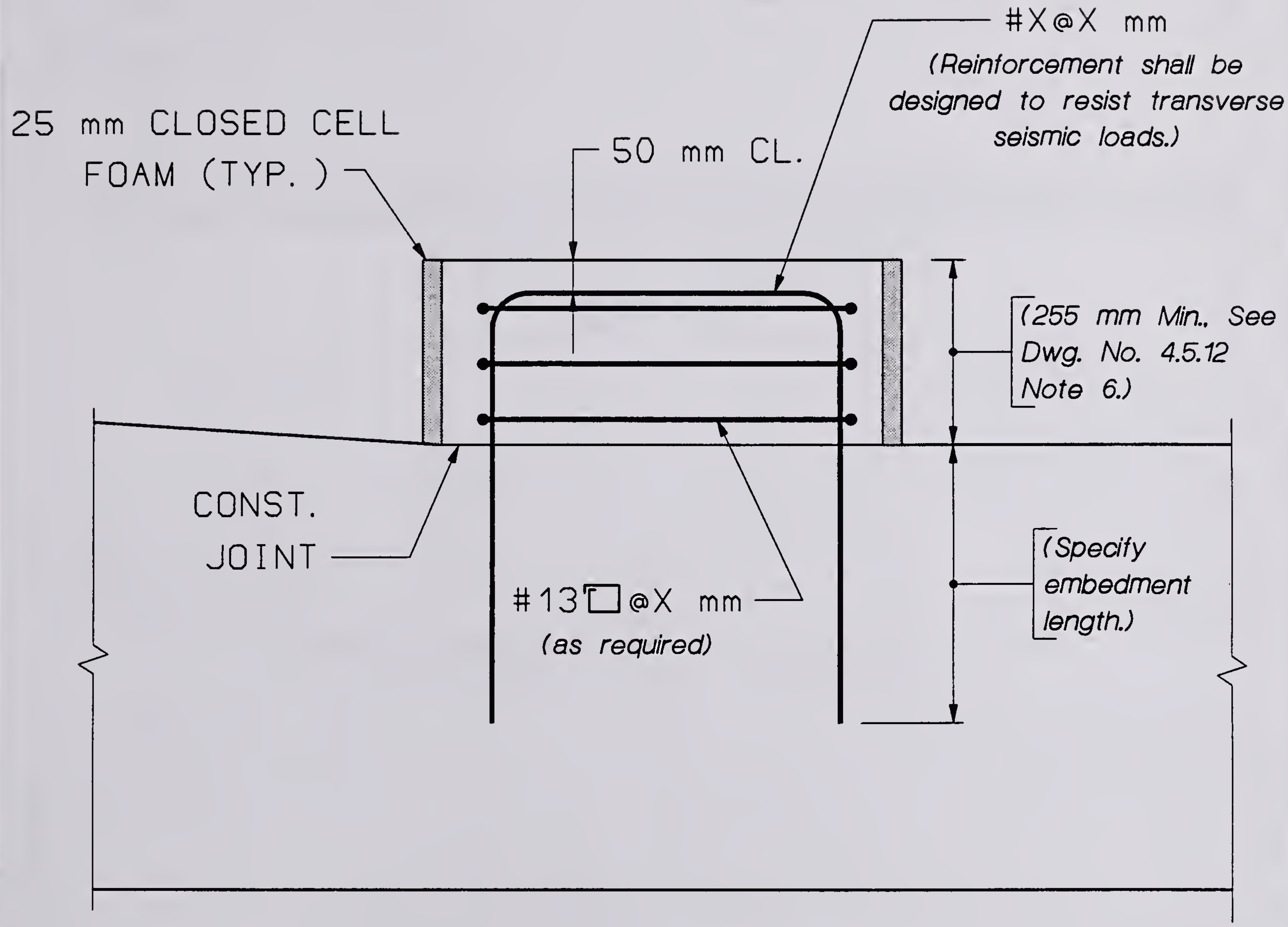
SECTION 8

SCALE 1:10

PLAN SECTION @ UTILITY BAY
FOR JOINT AT PIER
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
4.5.15


#X@X mm
(Reinforcement shall be designed to resist transverse seismic loads.)
25 mm CLOSED CELL FOAM (TYP.)
50 mm CL.
(255 mm Min., See Dwg. No. 4.5.12 Note 6.)
CONST. JOINT
#13 □ @X mm
(as required)
(Specify embedment length.)

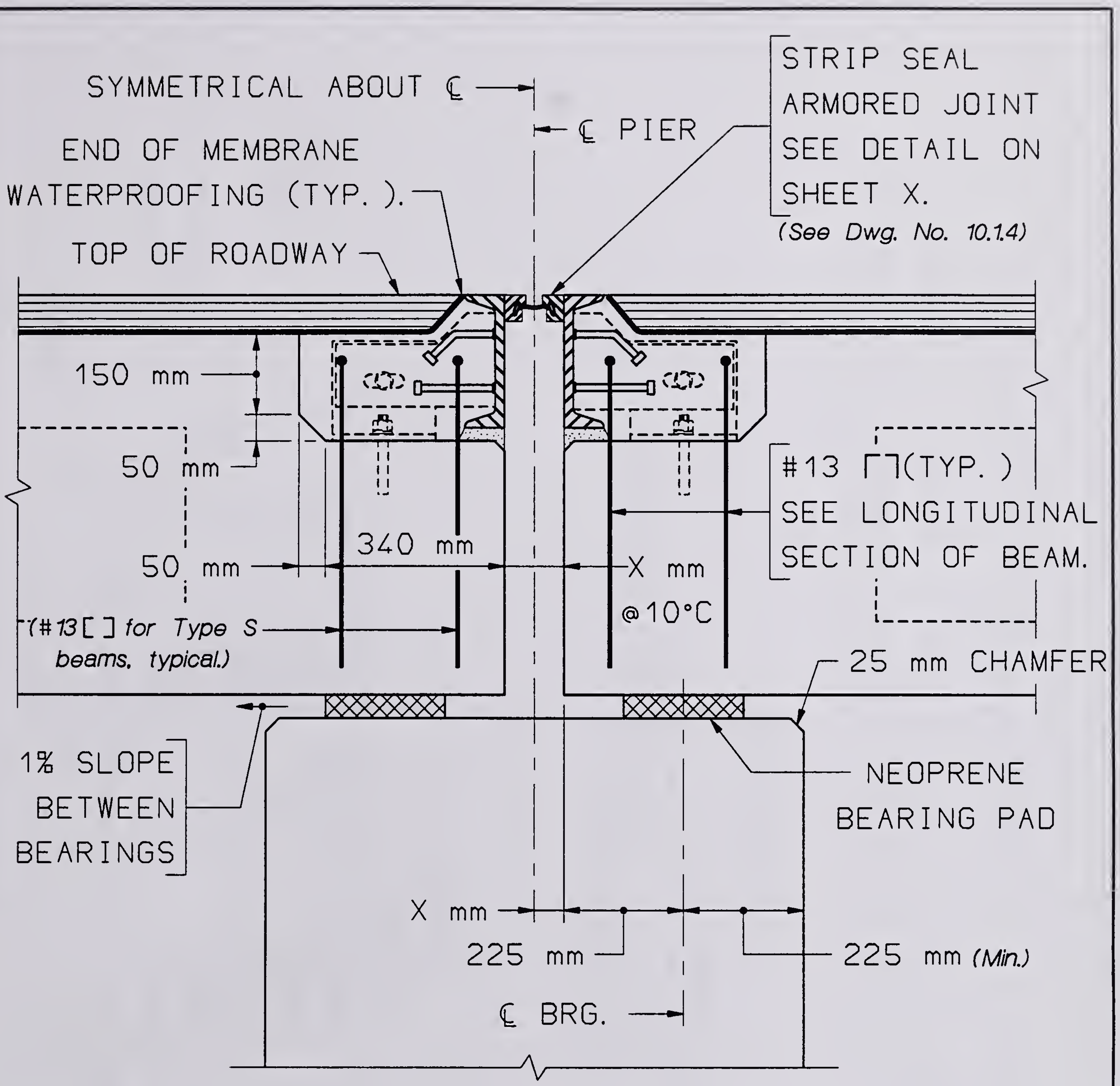
SECTION 10

SCALE 1:10

NOTES:

1. Only the transverse seismic reinforcement is shown above. All other pier reinforcement has been omitted for clarity.
2. The designer shall verify that the above reinforcement does not interfere with the normal pier reinforcement and modify as necessary.

MASS HIGHWAY BRIDGE MANUAL	VERT. SECTION @ UTILITY BAY FOR JOINT AT PIER PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.5.16**


SYMMETRICAL ABOUT ℄
℄ PIER
STRIP SEAL ARMORED JOINT SEE DETAIL ON SHEET X.
(See Dwg. No. 10.1.4)
END OF MEMBRANE WATERPROOFING (TYP.).
TOP OF ROADWAY
150 mm
50 mm
#13 ⌐¬(TYP.) SEE LONGITUDINAL SECTION OF BEAM.
50 mm
340 mm
X mm @10°C
(#13 [ ] for Type S beams, typical.)
25 mm CHAMFER
1% SLOPE BETWEEN BEARINGS
NEOPRENE BEARING PAD
X mm
225 mm
225 mm (Min.)
℄ BRG.

NOTE:

REMAINDER OF REINFORCEMENT HAS BEEN OMITTED FOR CLARITY.

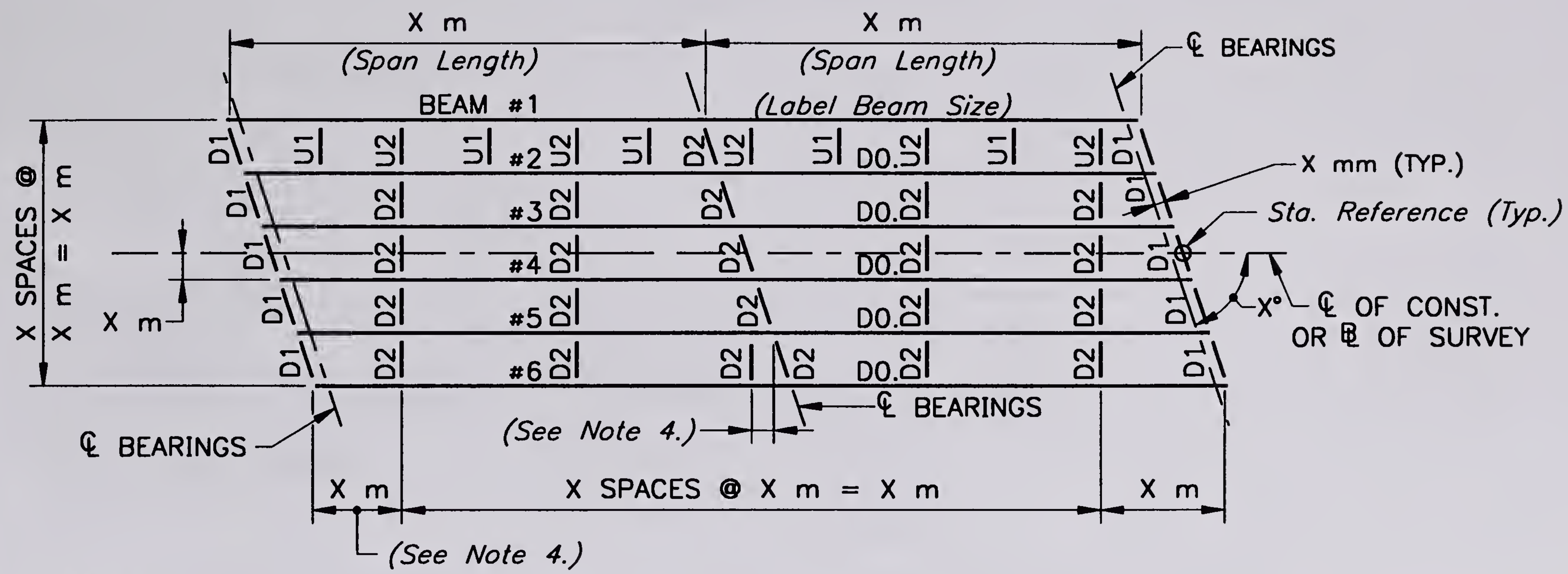
DETAILS OVER PIER

(Draw to 1:10 scale min.)

NOTE:
This detail is not used for Type SI and SII beams.

MASSHIGHWAY BRIDGE MANUAL	TYPICAL ROADWAY SECTION FOR JOINT AT PIER PIER DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **4.5.17**

Plot Scale = 1:100



NOTES:

1. D1 = CXxX (TYP. END DIAPHRAGM)
   D2 = CXxX (TYP. INTERMEDIATE DIAPHRAGM)
   U1 = W100x19 (TYP. UTILITY SUPPORT BETWEEN DIAPHRAGMS) *(Utility under sidewalk shown.)*
   U2 = W100x19 WITH L76x76x9.5 (TYP. UTILITY SUPPORT AT DIAPHRAGMS)
2. SEE SHEET X FOR DIAPHRAGM AND UTILITY SUPPORT DETAILS.
3. THE MAIN LOAD CARRYING MEMBERS ARE XXX.

FRAMING PLAN

SCALE (1:100 min.)

NOTES:

1. *The framing plan shall be drawn full length without breaks and to scale on the construction plans. Show the extent of and label all cover plates and splices. Dimension the utility support locations. Include all relevant survey data and north arrow.*
2. *Where utilities interfere with the typical end diaphragm, provide an alternative end diaphragm detail.*
3. *Continuous two-span bridge shown. Simple and multiple continuous span bridges are similar.*
4. *The minimum distance between a skewed and square diaphragm or utility support shall be 600 mm.*

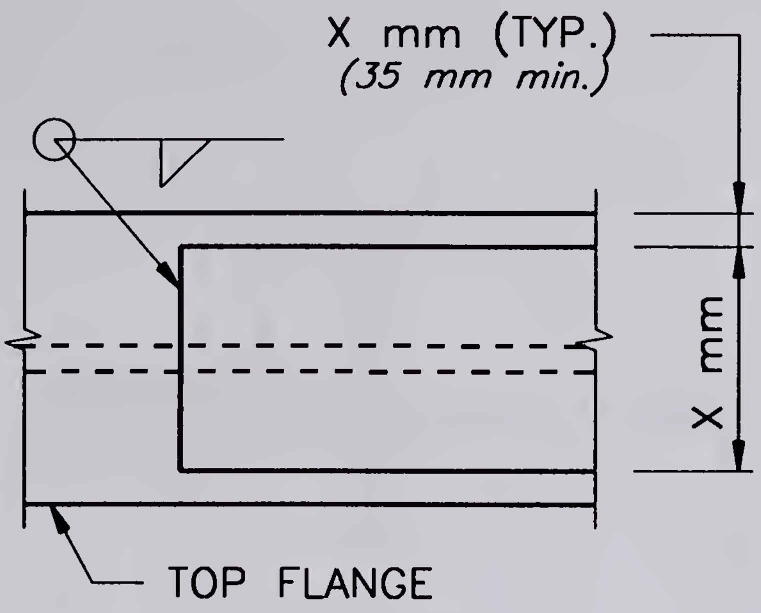
MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL FRAMING PLAN
STRINGERS

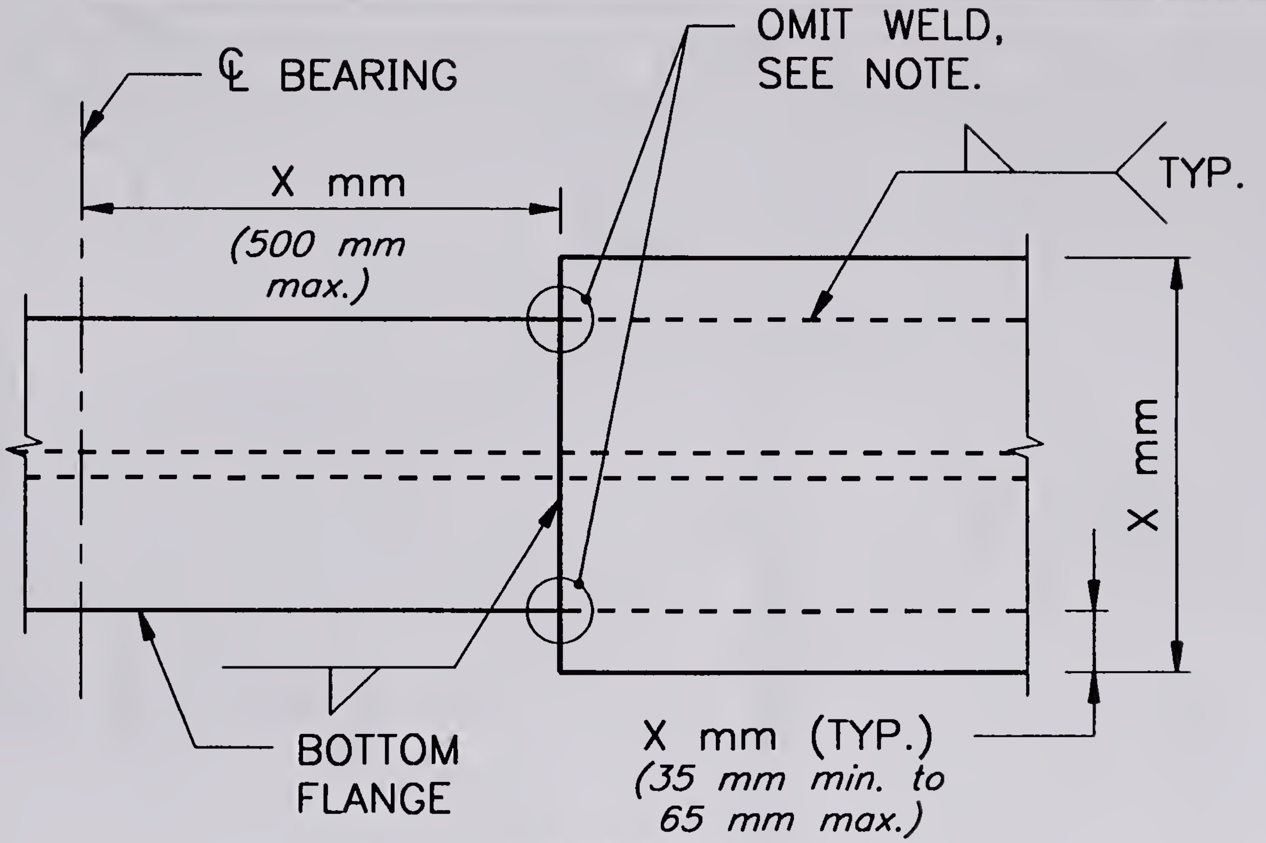
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.1

Plot Scale = 1:10



AT TOP FLANGE



AT BOTTOM FLANGE

NOTE: TERMINATE LONGITUDINAL AND TRANSVERSE WELDS 25 mm FROM THE INTERSECTION OF THE COVER PLATE WITH THE EDGE OF FLANGE. *(Include note as required.)*

COVER PLATE DETAILS

SCALE (1:10 min.)

NOTES:

1. *The above drawings are not to scale and show the preferred method of attachment. Modify the details as required to suit the project.*
2. *Cover plates are to be in one piece and shall be limited to one at any flange. The minimum cover plate thickness shall be 12 mm.*
3. *The extent of any cover plates welded to the top flange shall be in accordance with AASHTO specifications.*
4. *Weld sizes in the above table are minimum sizes only. The designer is responsible for assuring the weld size is adequate.*

Max. Plate & Flange Thickness, mm	*Min. Size Of Fillet Weld, mm*
12 TO 20	6
OVER 20	8

MASS HIGHWAY
BRIDGE
MANUAL

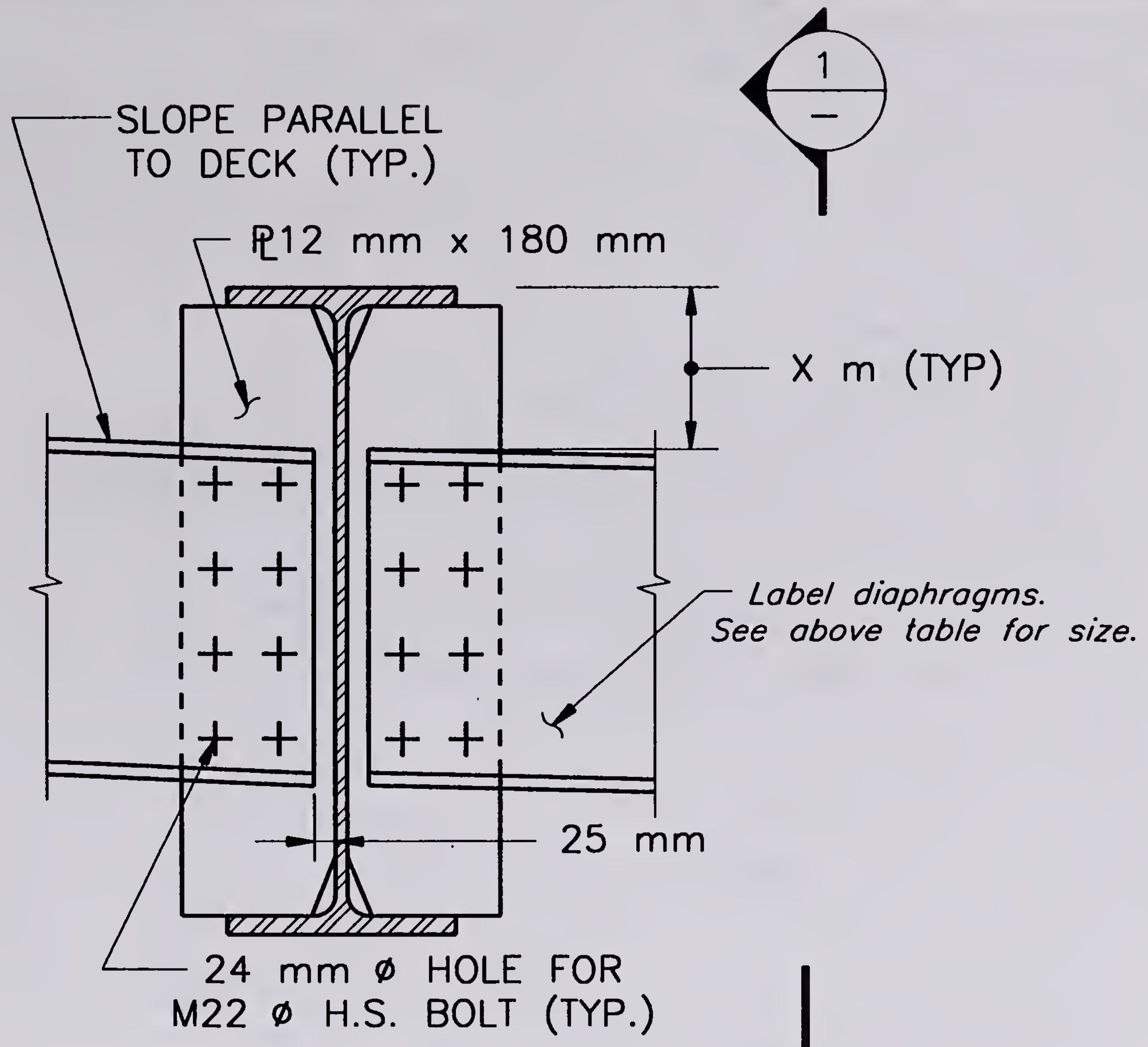
COVER PLATE DETAILS
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

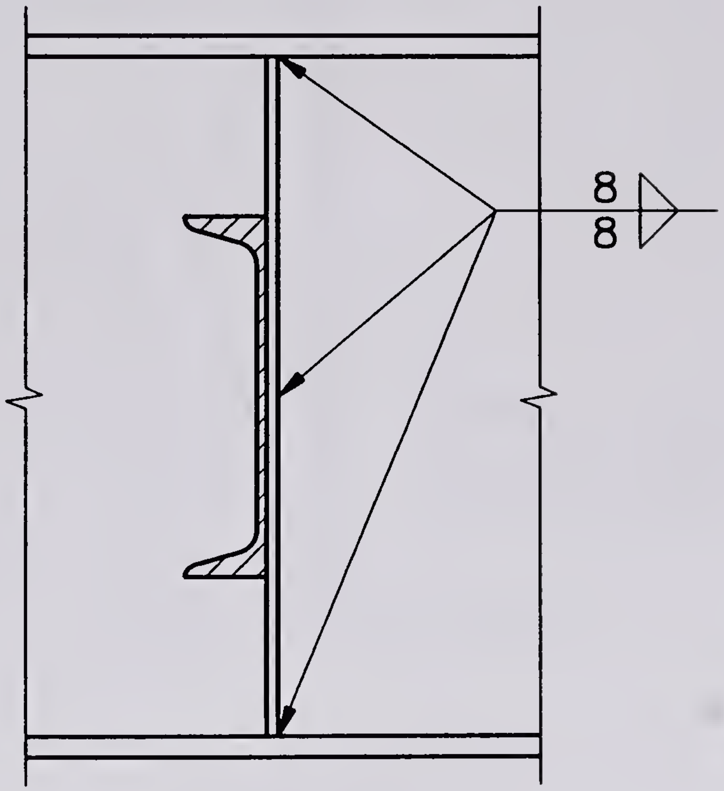
DRAWING NUMBER
5.1.2

Plot Scale = 1:10

Stringer	Diaphragm	H.S. Bolts
W840 – W920	MC460x63.5	10
W690 – W760	C380x50	8
W530 – W610	C310x31	6


1
—
SLOPE PARALLEL TO DECK (TYP.)
℞12 mm x 180 mm
X m (TYP)
Label diaphragms. See above table for size.
25 mm
24 mm ø HOLE FOR M22 ø H.S. BOLT (TYP.)

ELEVATION VIEW



SECTION 1

NOTE: SEE COPE DETAILS ON SHEET X.

INTERMEDIATE DIAPHRAGM DETAILS

SCALE (1:10 min.)

NOTES:

1. *Include bolt hole spacing and edge distances in the "Elevation View" on the construction plans.*
2. *The above drawings are not to scale. Modify the details as necessary to suit the project.*
3. *Interior diaphragms shall be centered on the stringers.*
4. *Maximum spacing of diaphragms shall be 7.5 m.*

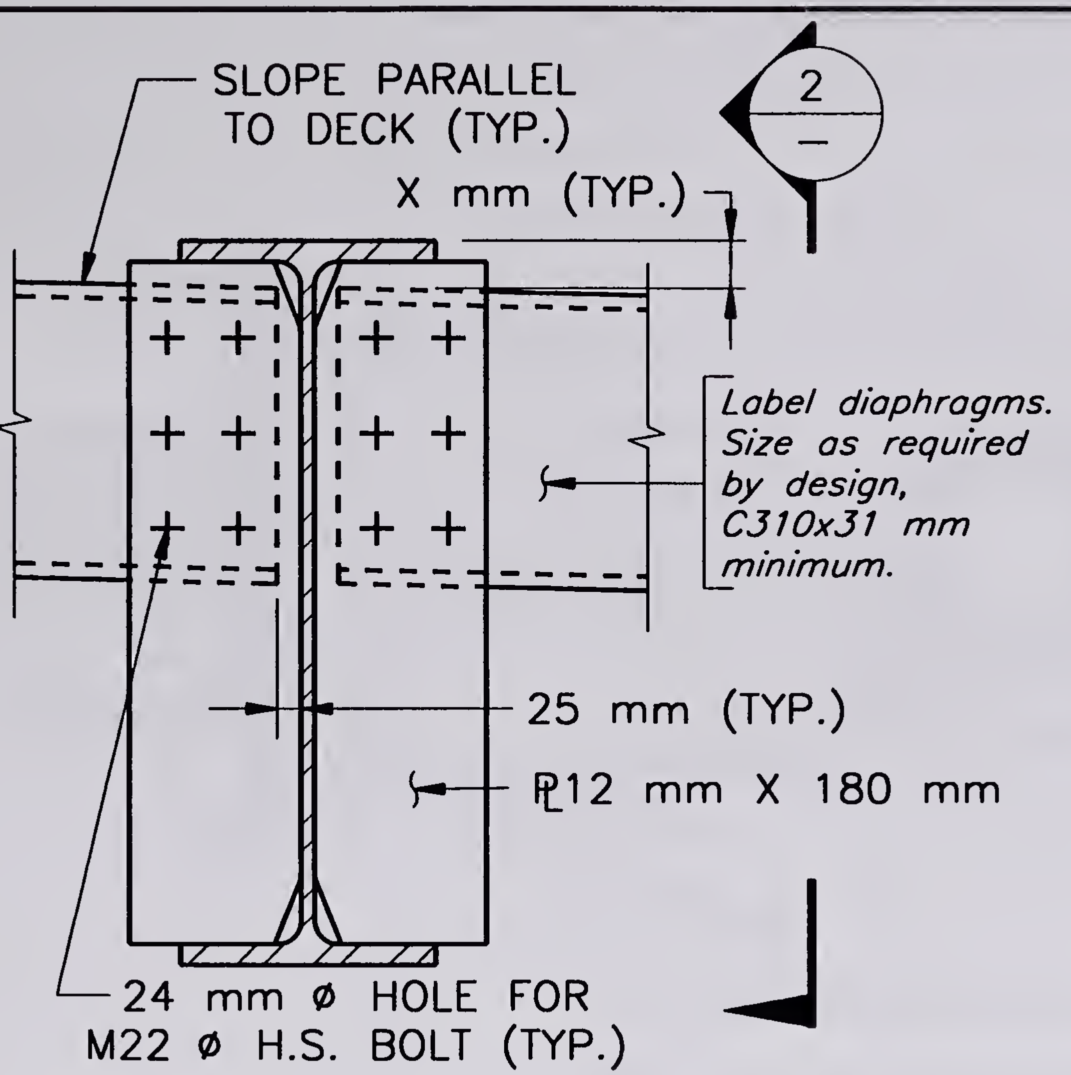
MASSHIGHWAY
BRIDGE
MANUAL

INTERMEDIATE DIAPHRAGM
DETAILS
STRINGERS

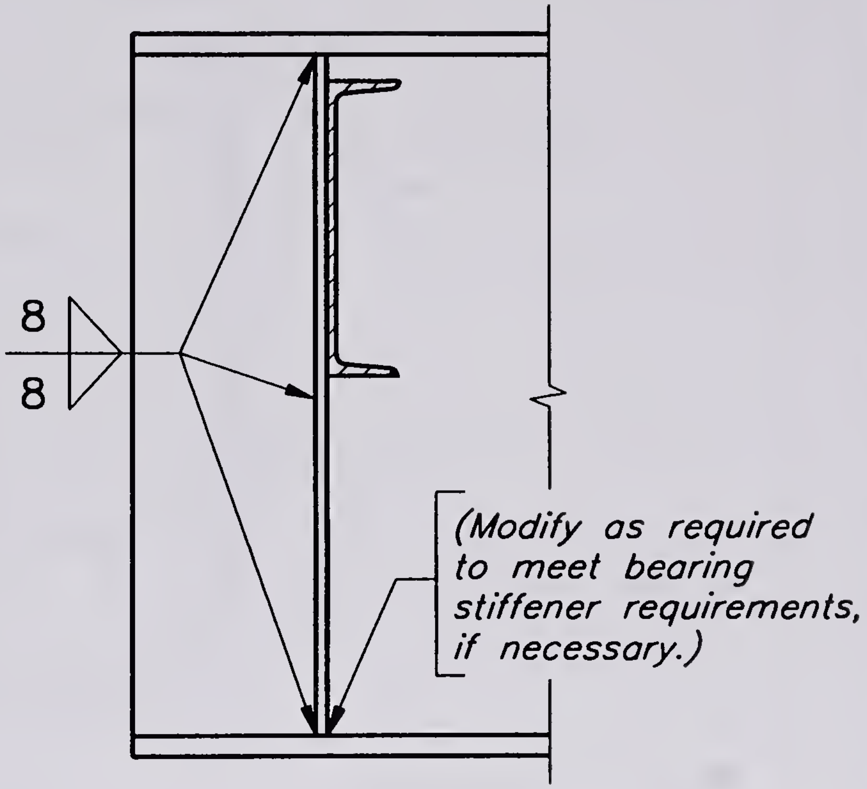
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.3

Plot Scale = 1:10


2
—
SLOPE PARALLEL TO DECK (TYP.)
X mm (TYP.)
Label diaphragms. Size as required by design, C310x31 mm minimum.
25 mm (TYP.)
℞12 mm X 180 mm
24 mm ø HOLE FOR M22 ø H.S. BOLT (TYP.)

ELEVATION VIEW


8
8
(Modify as required to meet bearing stiffener requirements, if necessary.)

SECTION 2

NOTE: SEE COPE DETAIL ON SHEET X.

END DIAPHRAGM DETAILS

SCALE (1:10 min.)

NOTES:

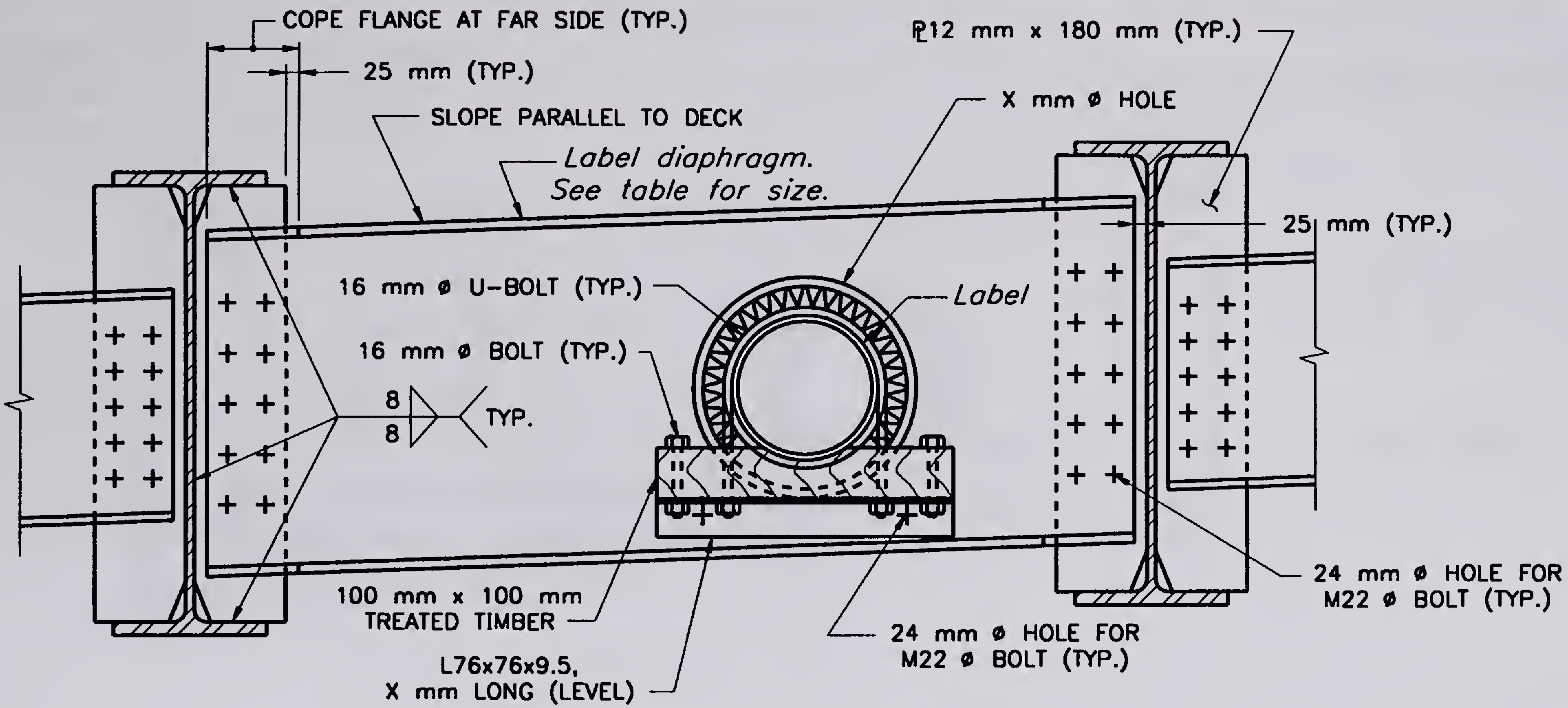
1. *Include the bolt hole spacing and edge distances in the "Elevation View" on the construction plans.*
2. *The above drawings are not to scale. Modify the details as necessary to suite the project. If connection plate is also required as a bearing stiffener, make all necessary changes to plate size and attachments to meet AASHTO requirements.*
3. *Locate the end diaphragm as close to the top flange as possible.*
4. *End diaphragms shall be placed parallel to the centerline of bearings as shown in the Framing Plan.*
5. *Details shown on Drawing No. 5.2.7 shall be used if transverse seismic loads exceeds the capacity of the details shown on this drawing.*

MASS HIGHWAY
BRIDGE
MANUAL

END DIAPHRAGM DETAILS
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.4



AT INTERMEDIATE DIAPHRAGM LOCATION

NOTE: SEE COPE DETAILS ON SHEET X.

UTILITY SUPPORT DETAILS

SCALE (1:10 min.)

Stringer	*Diaphragms*
W920	W690x140
W840	W690x140
W760	W610x113
W690	W610x113
W610	W460x89
W530	W460x89

NOTES:

1. *Above drawing is not to scale. Modify the details as necessary to suit project.*
2. *Combine the above detail with the detail for utility supports between diaphragms (Dwg. No. 5.1.7). For a utility bay located under a sidewalk, see Dwg. No. 5.1.6.*
3. *Provide at least as many bolts for the attachment of the diaphragm utility support as required for a normal diaphragm. Include the bolt hole spacing and edge distances.*
4. *Dimension the locations of the diaphragm, the circular opening, as well as the support angle and bolts. Water pipe shown: for other utilities, provide the main supports only.*

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BRIDGE
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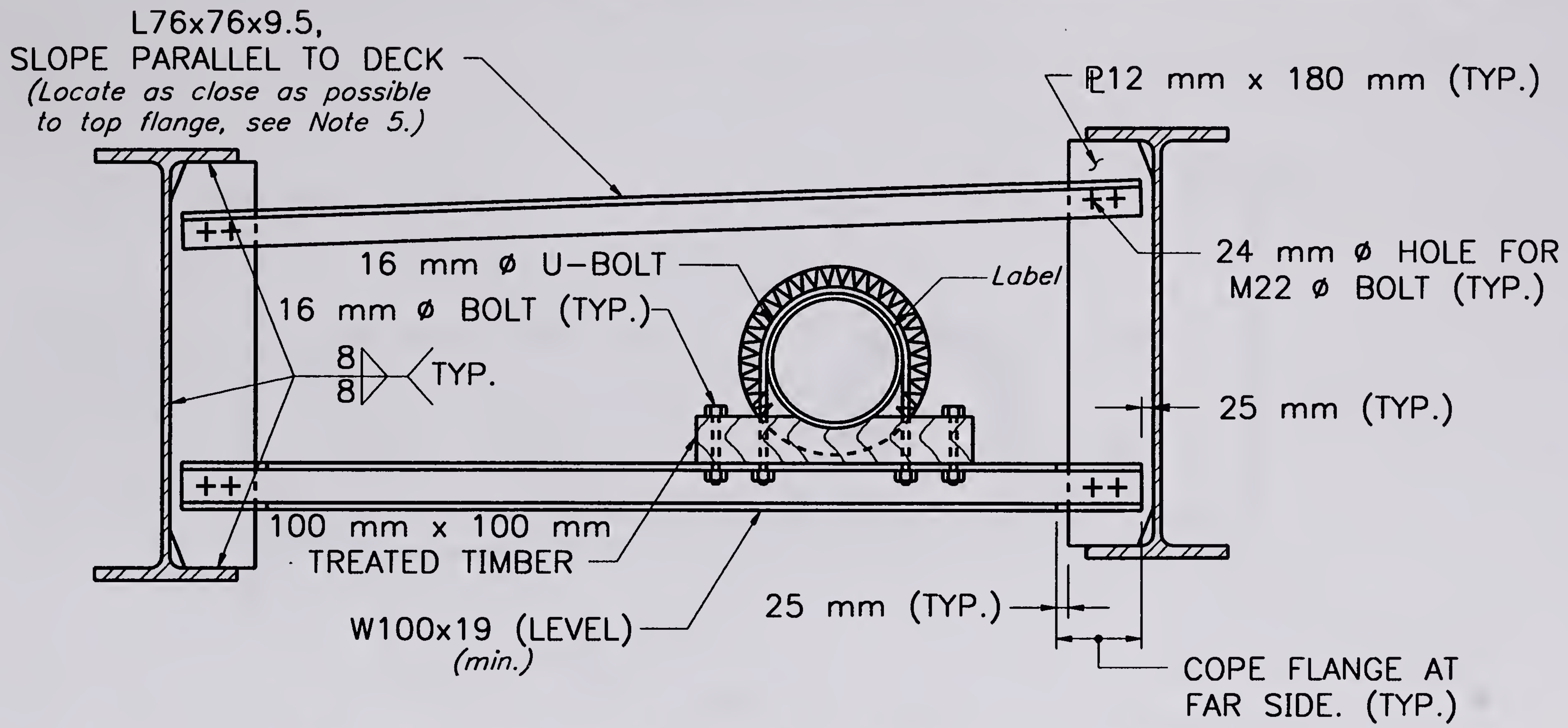
UTILITY SUPPORT DETAILS
AT DIAPHRAGMS
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.5

Plot Scale = 1:15


L76x76x9.5,
SLOPE PARALLEL TO DECK
(Locate as close as possible to top flange, see Note 5.)
PL12 mm x 180 mm (TYP.)
24 mm ø HOLE FOR M22 ø BOLT (TYP.)
16 mm ø U-BOLT
16 mm ø BOLT (TYP.)
Label
8
8
TYP.
25 mm (TYP.)
100 mm x 100 mm TREATED TIMBER
W100x19 (LEVEL) (min.)
25 mm (TYP.)
COPE FLANGE AT FAR SIDE. (TYP.)

AT INTERMEDIATE DIAPHRAGM LOCATION

NOTE: SEE COPE DETAILS ON SHEET X.

UTILITY SUPPORT DETAILS

SCALE: 1:X

NOTES:

1. Above drawing is not to scale. Modify the details as necessary to suit project.
2. This detail is for utility bays located under sidewalks only. For utility bays located under roadway or safety curb, see Dwg. No. 5.1.5
3. Combine the above detail with the detail for utility supports between diaphragms (Dwg. No. 5.1.7).
4. For utilities located under sidewalks, utilities should be placed as close as possible to the exterior beam to minimize interference with the approach slab.
5. Dimension the locations of all supports and bolts (with edge distances) on the plans. Water pipe shown; for other utilities, provide the main supports only.

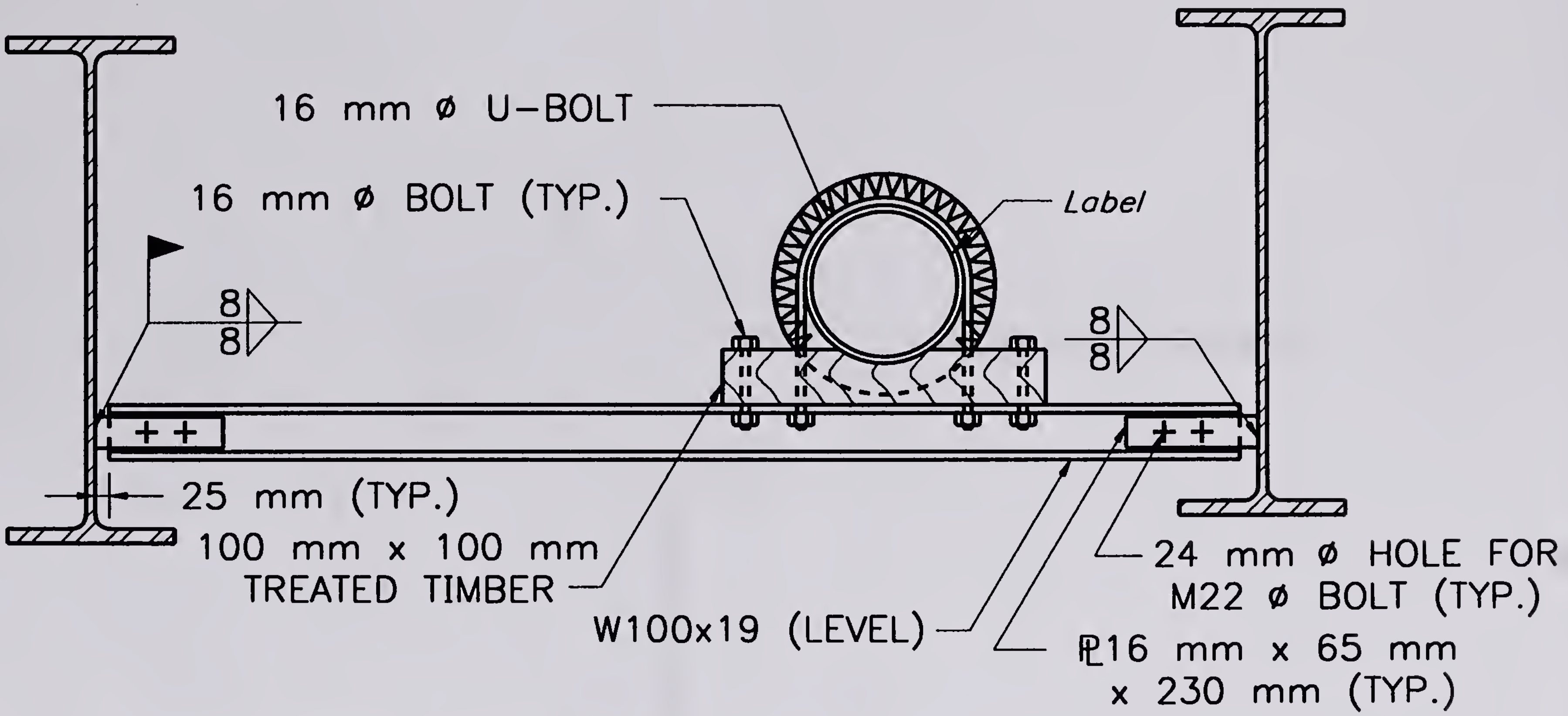
MASSHIGHWAY
BRIDGE
MANUAL

UTILITY SUPPORT DETAILS AT
DIAPHRAGMS (UNDER SIDEWALK)
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.6

Plot Scale = 1:15



BETWEEN DIAPHRAGMS

UTILITY SUPPORT DETAILS

SCALE 1:X

NOTES:

1. *Above drawing is not to scale. Modify the details as necessary to suit project.*
2. *For utility bays located under the roadway or safety curb, combine this detail with the detail shown on Dwg. No. 5.1.5.*
3. *For utility bay located under the sidewalk, combine this detail with the detail shown on Dwg. No. 5.1.6.*
4. *Dimension the locations of the supports and bolts (with edge distances) on the plans. Water pipe shown; for other utilities, provide the main supports only.*

MASSHIGHWAY
BRIDGE
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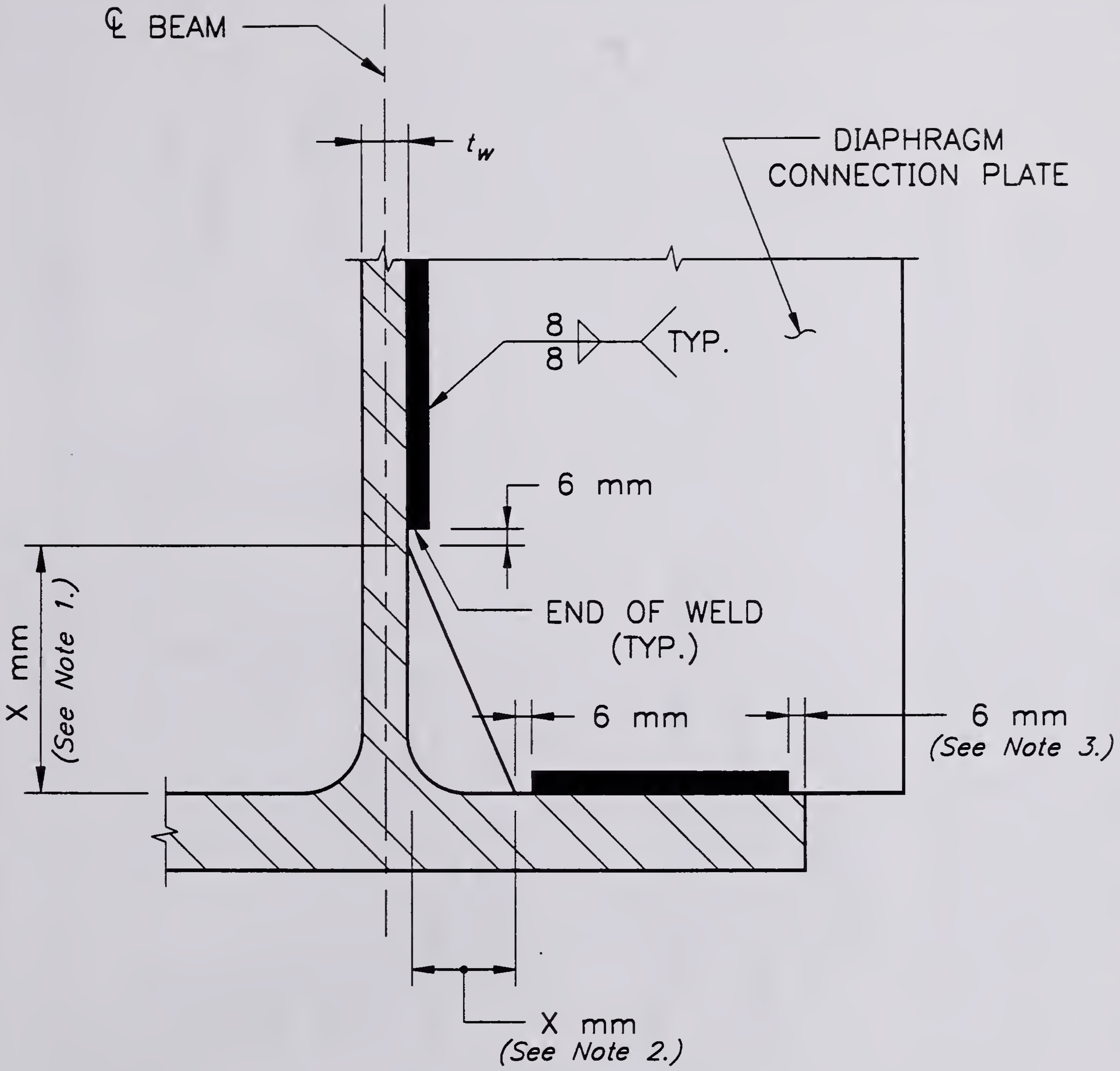
UTILITY SUPPORT DETAILS
BETWEEN DIAPHRAGMS
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.7



COPING DETAIL

NOT TO SCALE

NOTES:

1. Height of cope shall be 5 x t_W
2. Width of cope shall be 2 x t_W
3. Terminate weld 6 mm from edge of flange or connection plate, whichever is encountered first.
4. Where the end connection plate is also required as a bearing stiffener, the bottom of the connection plate shall be either milled to fit the bottom flange and fillet welded, or attached to the bottom flange with a full penetration weld. Modify the above detail with construction notes as required.

Plot Scale = 1:2.5

MASS HIGHWAY
BRIDGE
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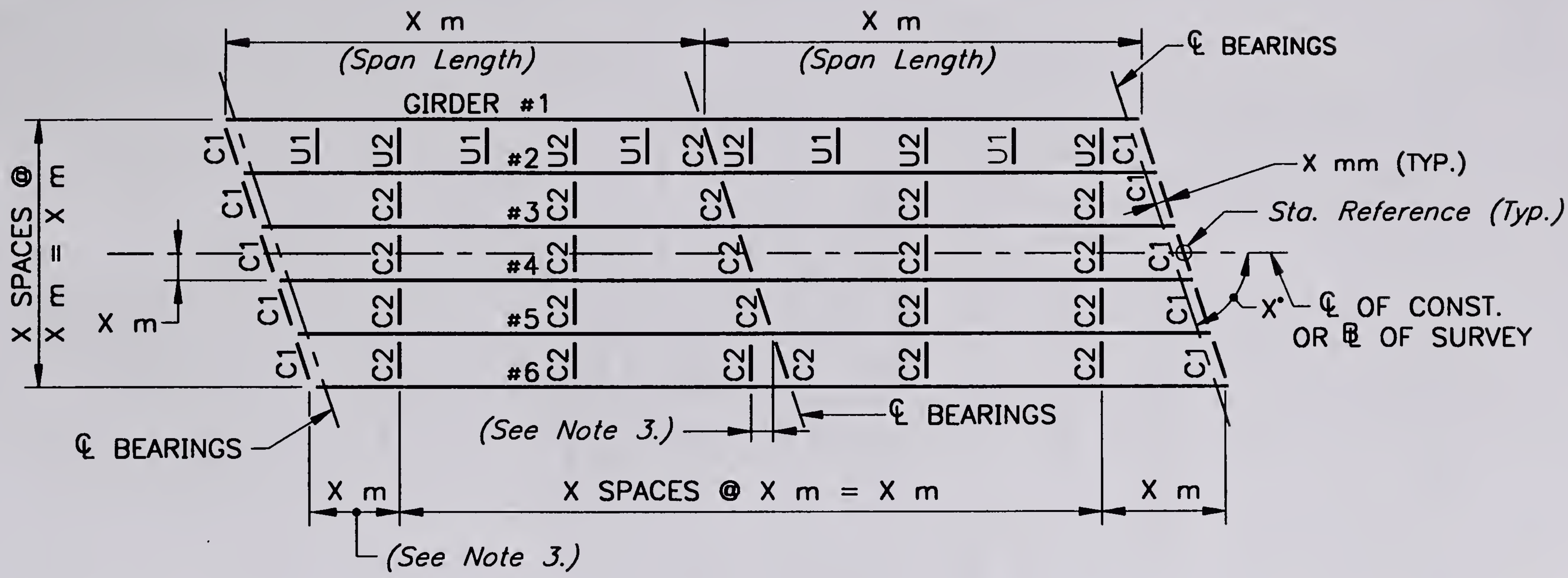
COPING DETAIL FOR
DIAPHRAGM CONN. PLATES
STRINGERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.1.8

Plot Scale = 1:100



NOTES:

1. C1 = TYP. END CROSS FRAME
   C2 = TYP. INTERMEDIATE CROSS FRAME
   U1 = W100x19 TYP. UTILITY SUPPORT BETWEEN CROSS FRAMES
   U2 = TYP. UTILITY SUPPORT AT CROSS FRAMES
2. SEE SHEET X FOR CROSS FRAME AND UTILITY SUPPORT DETAILS.
3. THE MAIN LOAD CARRYING MEMBERS ARE XXX.

FRAMING PLAN

SCALE (1:100 min.)

NOTES:

1. *The framing plan shall be drawn full length without breaks and to scale on the construction plans. Show the extent of and label all longitudinal stiffeners and splices. Dimension the utility support locations. Include all relevant survey data and north arrow.*
2. *Continuous two-span bridge shown. Simple and multiple continuous span bridges are similar.*
3. *The minimum distance between a skewed and square diaphragm or utility support shall be 600 mm.*

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL FRAMING PLAN
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.1

NOTES:

1. For the design of welded girders, the span to depth ratio shall be as specified in Part I of the Bridge Manual.
2. The flanges shall be sized as required by design and as follows:
   - For shipping and erection safety, the ratio of the length to width of the compression flange shall be limited to 100 where practical (even at the expense of some additional steel).
   - The flange width may vary over the length of the girder; however, constant width flanges are preferred. The top and bottom flanges need not be of the same width.
   - The thickness of flanges shall be a minimum of 20 mm to a maximum of 50 mm for simple span bridges. The flange thickness may exceed 50 mm in the negative moment of continuous span bridges utilizing haunched or through plate girders.
3. The web plate thickness shall not be less than 10 mm. The designer shall consider thicker web plates to eliminate transverse stiffeners (see Part I of the Bridge Manual).
4. Where intermediate stiffeners are required, the stiffeners shall conform to the following:
   - Intermediate stiffeners shall be cut short of the tension flange unless it also serves as a cross frame connection plate (see Dwg. No. 5.2.4).
   - Intermediate stiffeners shall be placed, in pairs, on both sides of the web unless a longitudinal stiffener is employed on one side.
   - Intermediate stiffeners shall not be placed on the outside face of the exterior girders.
   - The minimum plate size of the stiffeners shall be 10 mm X 130 mm for spans 27 m to 36 m and 10 mm X 150 mm for spans 36 m to 45 m.
   - Stiffeners shall be located a minimum of 900 mm from a splice.
5. The use of longitudinal stiffeners shall be avoided unless required by design. The longitudinal stiffener shall be placed on the opposite side of the web from the transverse stiffeners. For exterior girders, the longitudinal stiffener should be placed on the outside face.

Plot Scale = 1:1

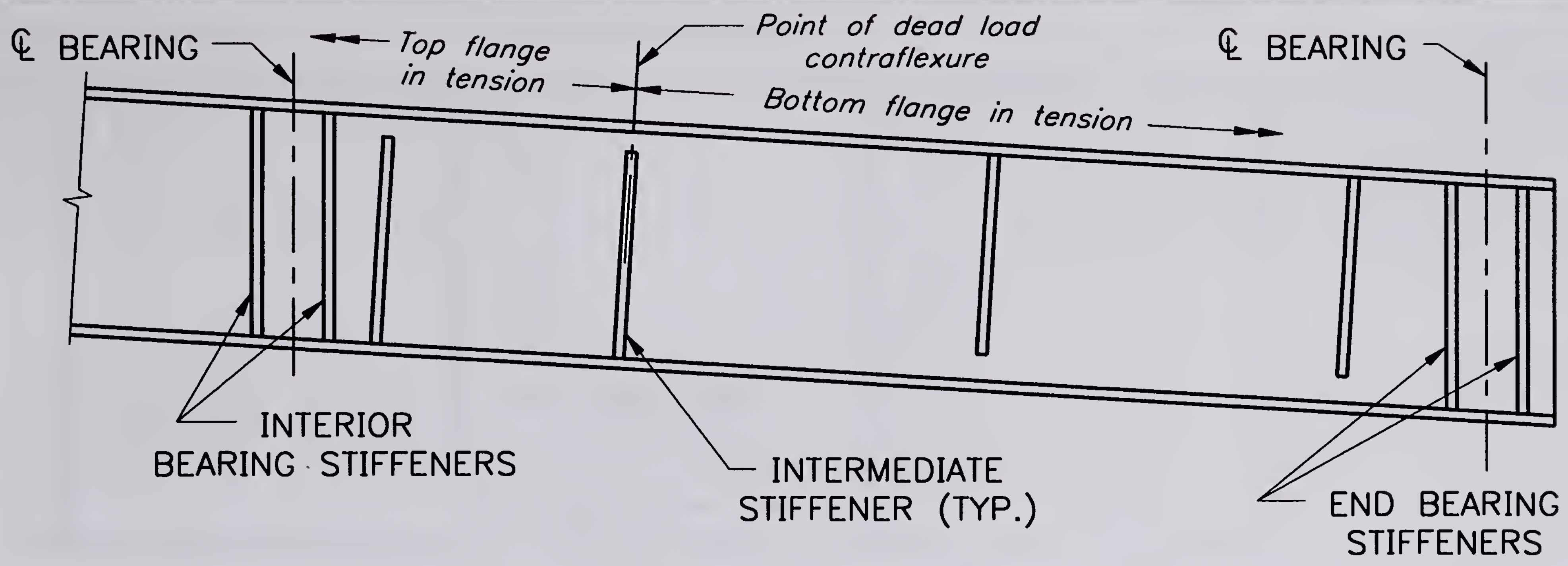
MASS HIGHWAY
BRIDGE
MANUAL

DESIGNER NOTES
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.2

Plot Scale = 1:50


℄ BEARING
Top flange in tension
Point of dead load contraflexure
Bottom flange in tension
℄ BEARING
INTERIOR BEARING STIFFENERS
INTERMEDIATE STIFFENER (TYP.)
END BEARING STIFFENERS

NOTES:

1. THE FABRICATOR SHALL NOTE ON THE SHOP DRAWINGS OF ALL PLATE GIRDERS, THE LENGTH TO WIDTH RATIOS (L/B) OF ALL COMPRESSION FLANGES. THESE RATIOS SHALL BE CALCULATED AND NOTED FOR ALL CONDITIONS TO BE ENCOUNTERED BETWEEN THE TIME OF FABRICATION AND INCORPORATION INTO THE FINISHED STRUCTURE.
2. ALL STIFFENERS SHALL BE PERPENDICULAR TO THE WEB.
3. ALL BEARING STIFFENERS SHALL BE PLUMB.
4. INTERMEDIATE STIFFENERS SHALL BE PERPENDICULAR TO THE GIRDER FLANGES.
5. ENDS OF BEAMS SHALL BE FABRICATED SO THAT UNDER FULL DEAD LOAD THE ENDS WILL BE PLUMB.

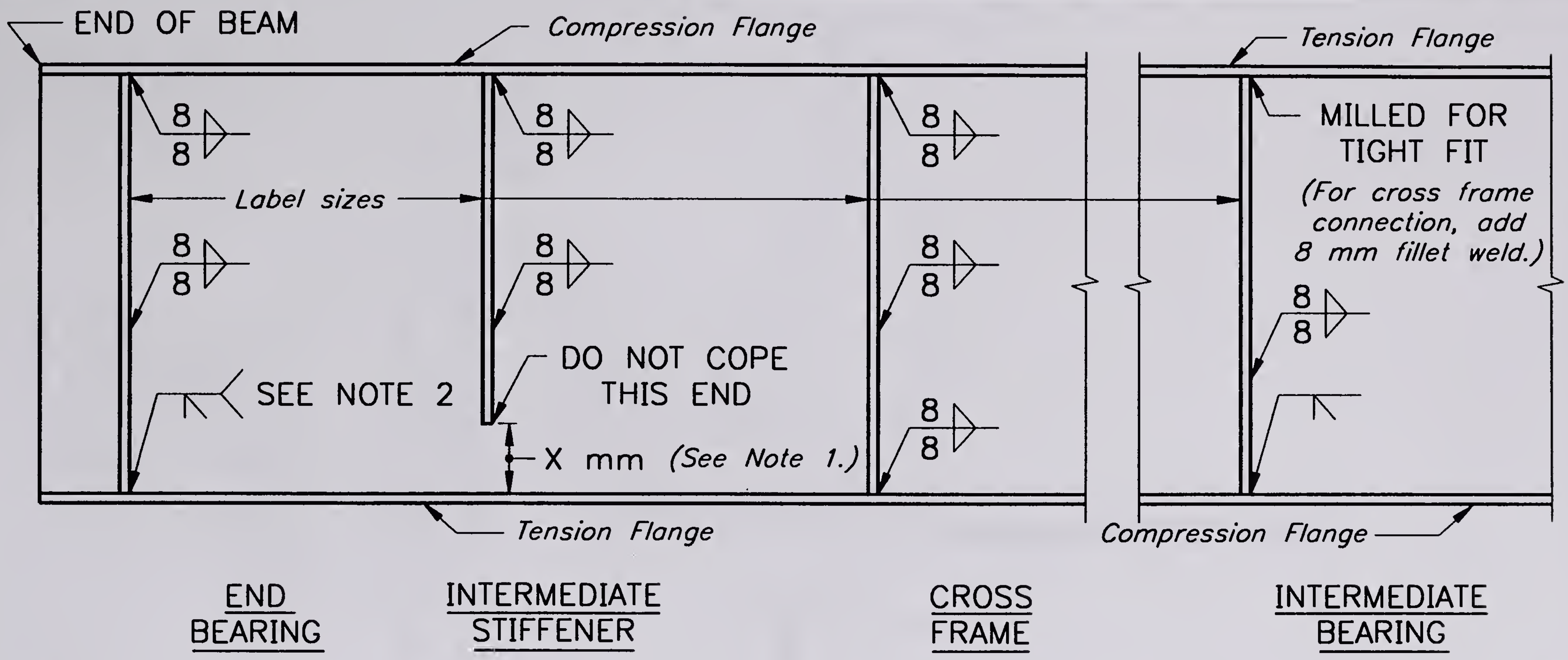
GIRDER ELEVATION

SCALE 1:X

NOTES:

1. *Include girder elevation for each girder type on the construction plans.*
2. *All main plates, welds, dimensions shall be labeled on plans for each girder type. Show location of any splices and stiffeners.*

Plot Scale = 1:20



NOTES:

1. SEE COPE DETAIL ON SHEET X FOR FURTHER DETAILS.
2. END BEARING STIFFENER PLATE AT BOTTOM FLANGE MAY BE MILLED FOR TIGHT FIT AND OMIT WELD.
2. END BEARING STIFFENER PLATE AT BOTTOM FLANGE MAY BE MILLED FOR TIGHT FIT AND WELDED WITH 8 mm FILLET WELDS BOTH SIDES OF PLATE. *(Use this note when end cross frame connection plates also serve as bearing stiffeners.)*

STIFFENER ATTACHMENTS

NOT TO SCALE

NOTES:

1. *Intermediate stiffener shall terminate above the tension flange a distance of 4 to 6 times the web thickness. Show the dimension on the plans.*
2. *Bearing stiffener plates shall be wide enough to extend to the outer edges of flange as a minimum.*

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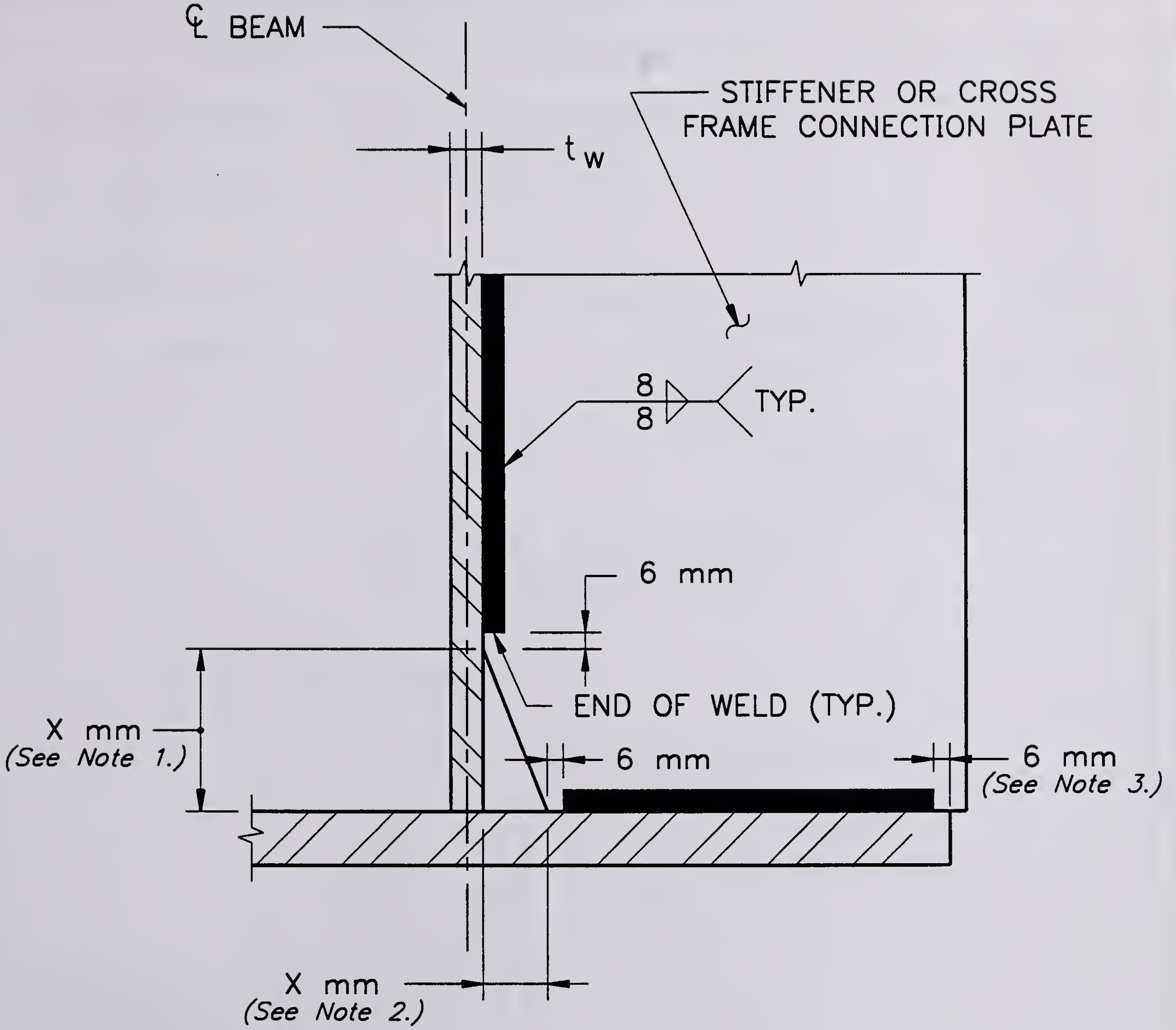
MANUAL

STIFFENER ATTACHMENT
DETAILS
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.4



NOTE:

AT STIFFENER LOCATIONS, MODIFY THE PLATE ATTACHMENT TO THE FLANGES AS SHOWN IN THE TYPICAL STIFFENER ATTACHMENTS ON SHEET X.

COPING DETAIL

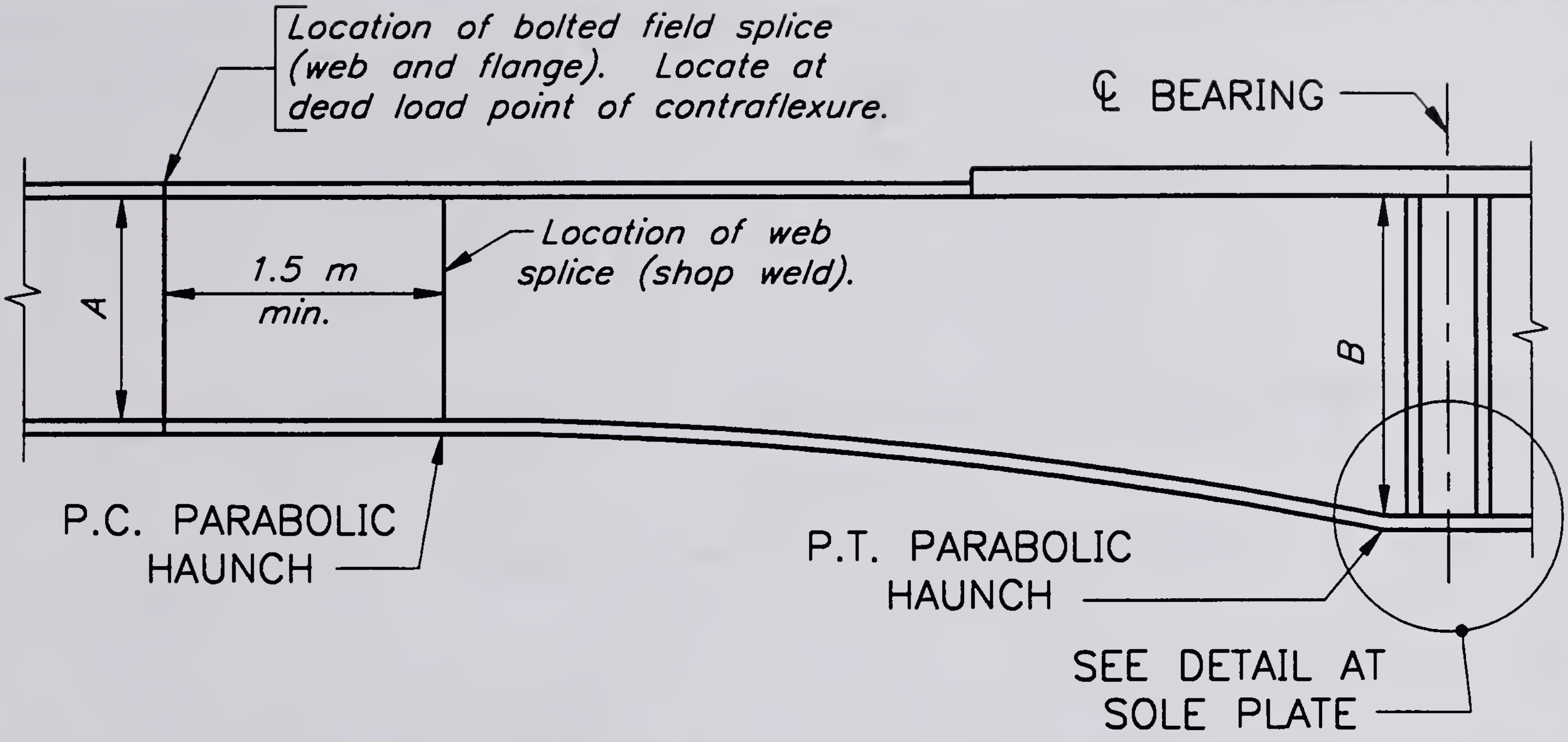
NOT TO SCALE

NOTES:

1. *Height of cope shall be 5 x* t_w
2. *Width of cope shall be 2 x* t_w
3. *Terminate weld 6 mm from edge of flange or connection plate, whichever is encountered first.*

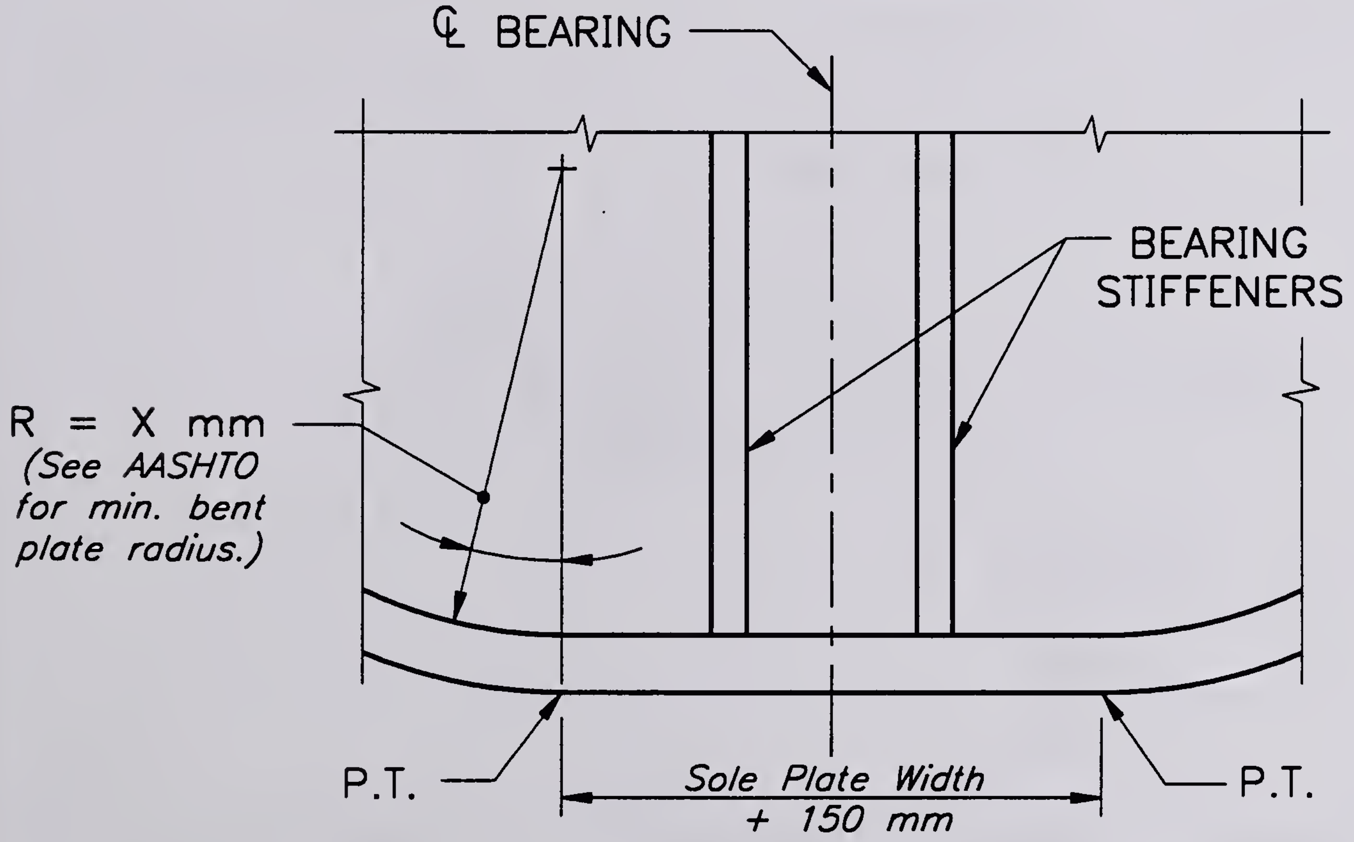
Plot Scale = 1:2.5

MASS HIGHWAY BRIDGE MANUAL	COPING DETAIL FOR TRANSVERSE PLATES PLATE GIRDERS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **5.2.5**


Location of bolted field splice (web and flange). Locate at dead load point of contraflexure.
℄ BEARING
1.5 m min.
A
Location of web splice (shop weld).
B
P.C. PARABOLIC HAUNCH
P.T. PARABOLIC HAUNCH
SEE DETAIL AT SOLE PLATE

GIRDER ELEVATION

SCALE 1:X


℄ BEARING
BEARING STIFFENERS
R = X mm
(See AASHTO for min. bent plate radius.)
P.T.
Sole Plate Width + 150 mm
P.T.

DETAIL AT SOLE PLATE

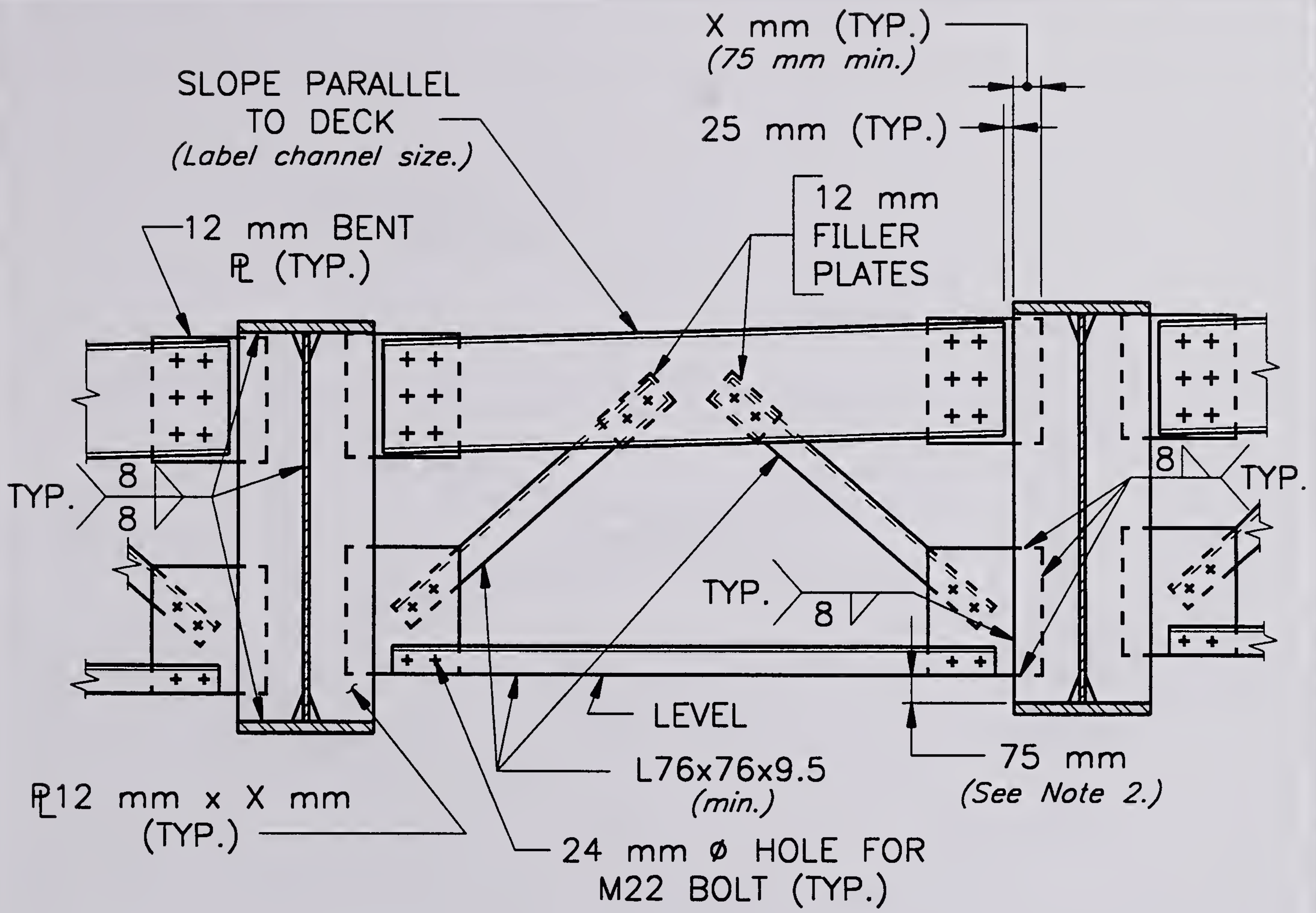
NOT TO SCALE

NOTES:

1. *Above drawings are not to scale. Include the above drawings on the construction plans with all relevant dimensions and plate sizes labeled.*
2. *Haunch shall be proportioned such that the ratio of web depths A/B=0.7.*
3. *Intermediate stiffeners shall be spaced so that they do not coincide with bolted field splices.*
4. *The location of splices shall be shown on the Framing Plan.*

MASS HIGHWAY BRIDGE MANUAL	PARABOLIC HAUNCHED GIRDERS PLATE GIRDERS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **5.2.6**

Plot Scale = 1:50



NOTE: SEE COPE DETAIL ON SHEET X.

END CROSS FRAME DETAILS

SCALE (1:20 min.)

Diaphragm	*H. S. Bolts (min.)*
MC460x63.5	10
C380x50	8
C310x31	6

NOTES:

1. *The above drawing is not to scale. Modify the details as necessary to suit project.*
2. *Cross frame shall be as deep as practical. Dimension the location of the angles and bolts (with edge distances) on this detail. Channel, angles and number of bolts to be as required by design.*
3. *End cross frames shall be placed parallel to the centerline of bearings as shown in the Framing Plan.*
4. *Size connection plate width as required for attachment of cross frame. If connection plates also serve as bearing stiffeners: plate shall be at least as wide as flange, plate shall meet AASHTO size requirements at a minimum, and modify the attachment of the plate to the bottom flange as required (see Dwg. No. 5.2.4).*

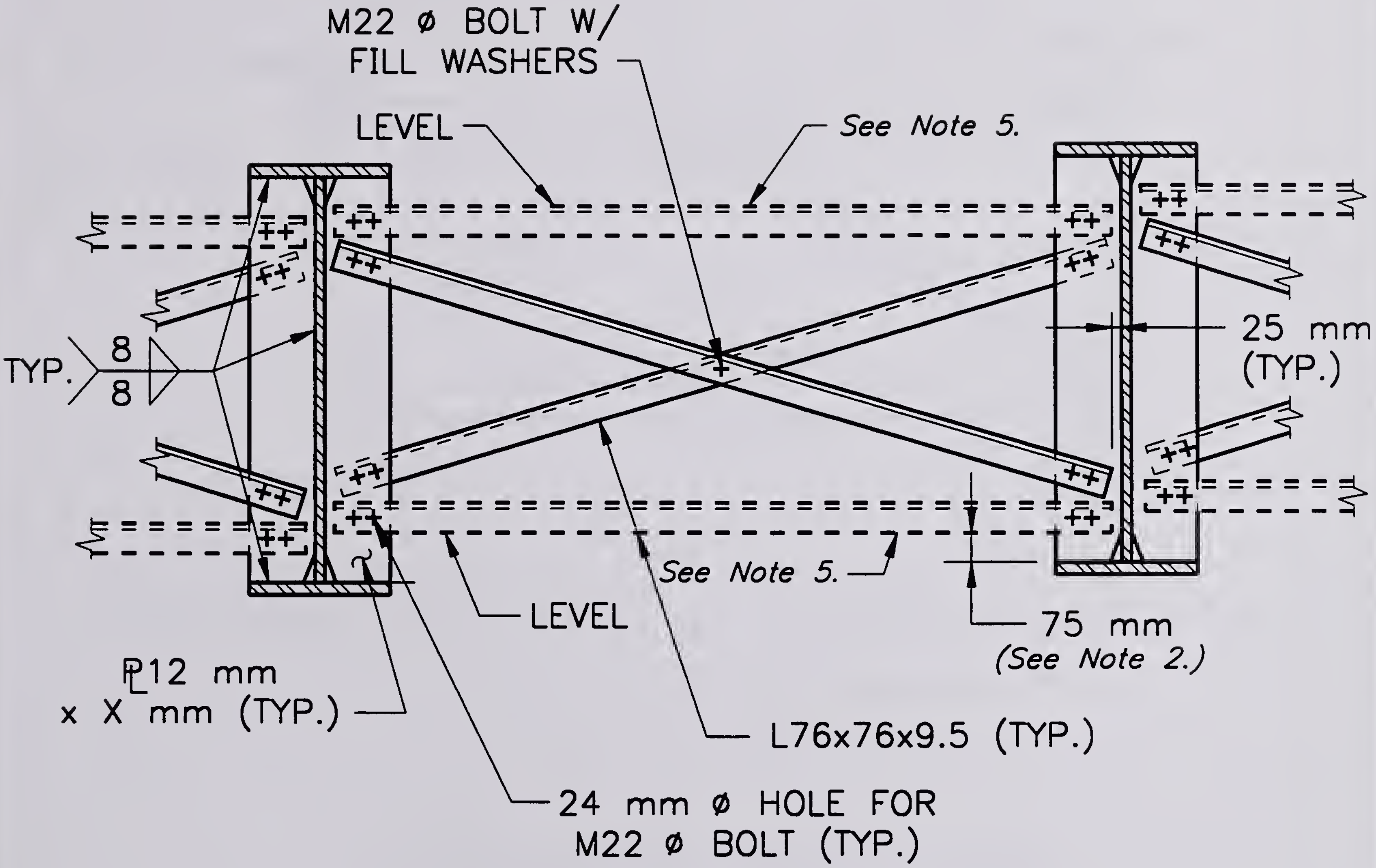
Plot Scale = 1:20

MASSHIGHWAY
BRIDGE
MANUAL

END CROSS FRAME DETAILS
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.7



NOTE: SEE COPE DETAIL ON SHEET X.

INTERMEDIATE CROSS FRAME DETAILS

SCALE 1:X

NOTES:

1. *The above drawing is not to scale. Modify the details as necessary to suit project.*
2. *Cross frames shall be as deep as practical. Dimension the location of the angles and bolt holes (with edge distances) on this detail.*
3. *Maximum spacing of cross frames shall not exceed 7.5 m.*
4. *Size the connection plate width as required for attachment of angles. If connection plates also serve as web stiffeners, plate size shall at a minimum meet AASHTO and the Bridge Manual requirements (See Dwg. No. 5.2.2).*
5. *Top and bottom L76x76x9.5 shall be used only if required by design.*

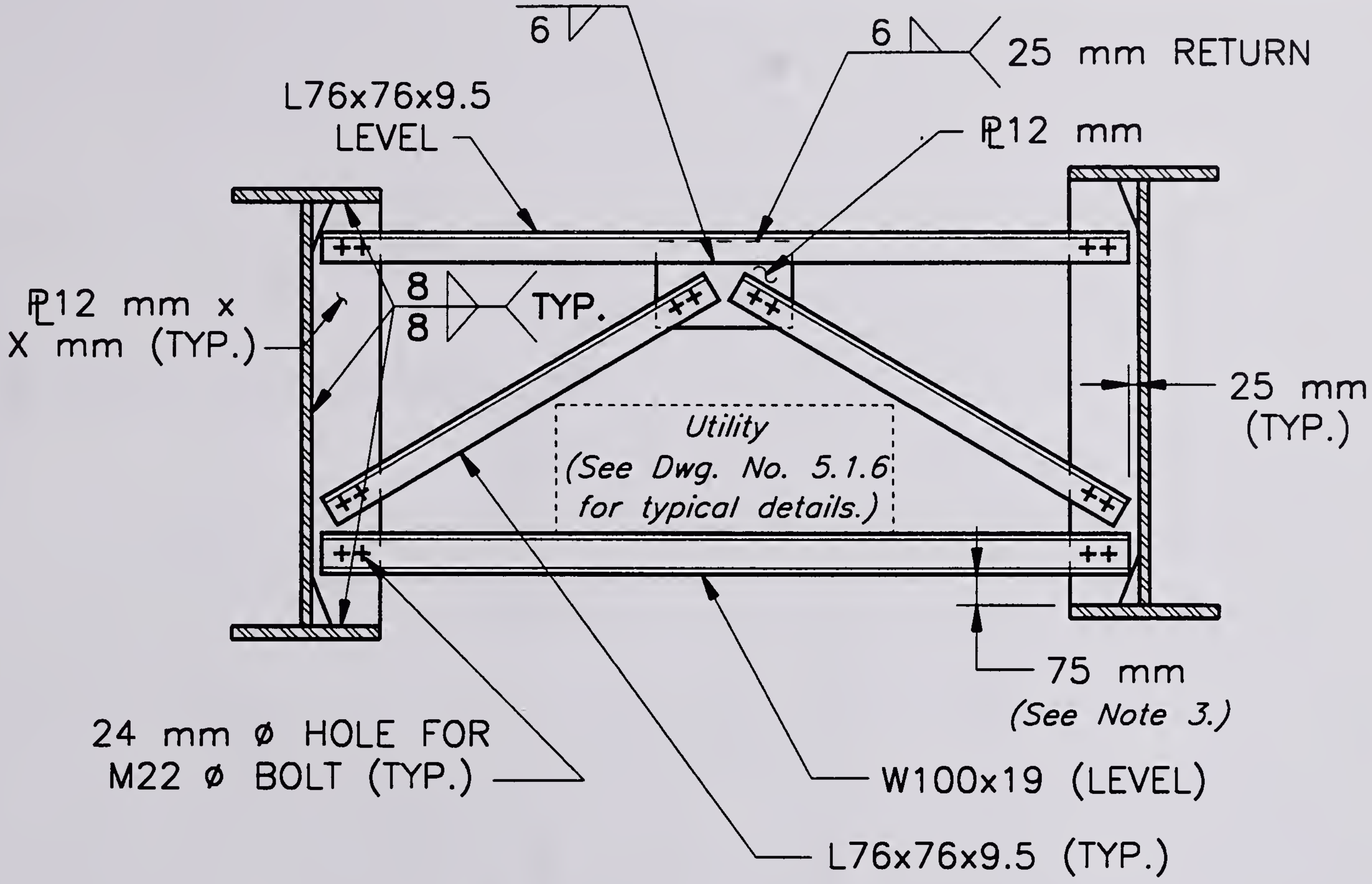
Plot Scale = 1:20

MASSHIGHWAY
BRIDGE
MANUAL

INTERMEDIATE CROSS FRAME
DETAILS
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.8



AT INTERMEDIATE CROSS FRAMES

NOTE: SEE COPE DETAIL ON SHEET X.

UTILITY SUPPORT DETAILS

SCALE 1:X

NOTES:

1. *The above drawing is not to scale. Modify the details as necessary to suit project.*
2. *Combine this drawing with the details shown on Dwg. No. 5.2.10.*
3. *Intermediate support frames shall be as deep as practical. Dimension the location of the angles, support, and bolt holes (with edge distances) on this detail.*
4. *Size the connection plate width as required for the attachment of angles and support. If the connection plates also serve as web stiffeners, plate size shall at a minimum meet AASHTO and the Bridge Manual requirements (see Dwg. No. 5.2.2).*

Plot Scale = 1:20

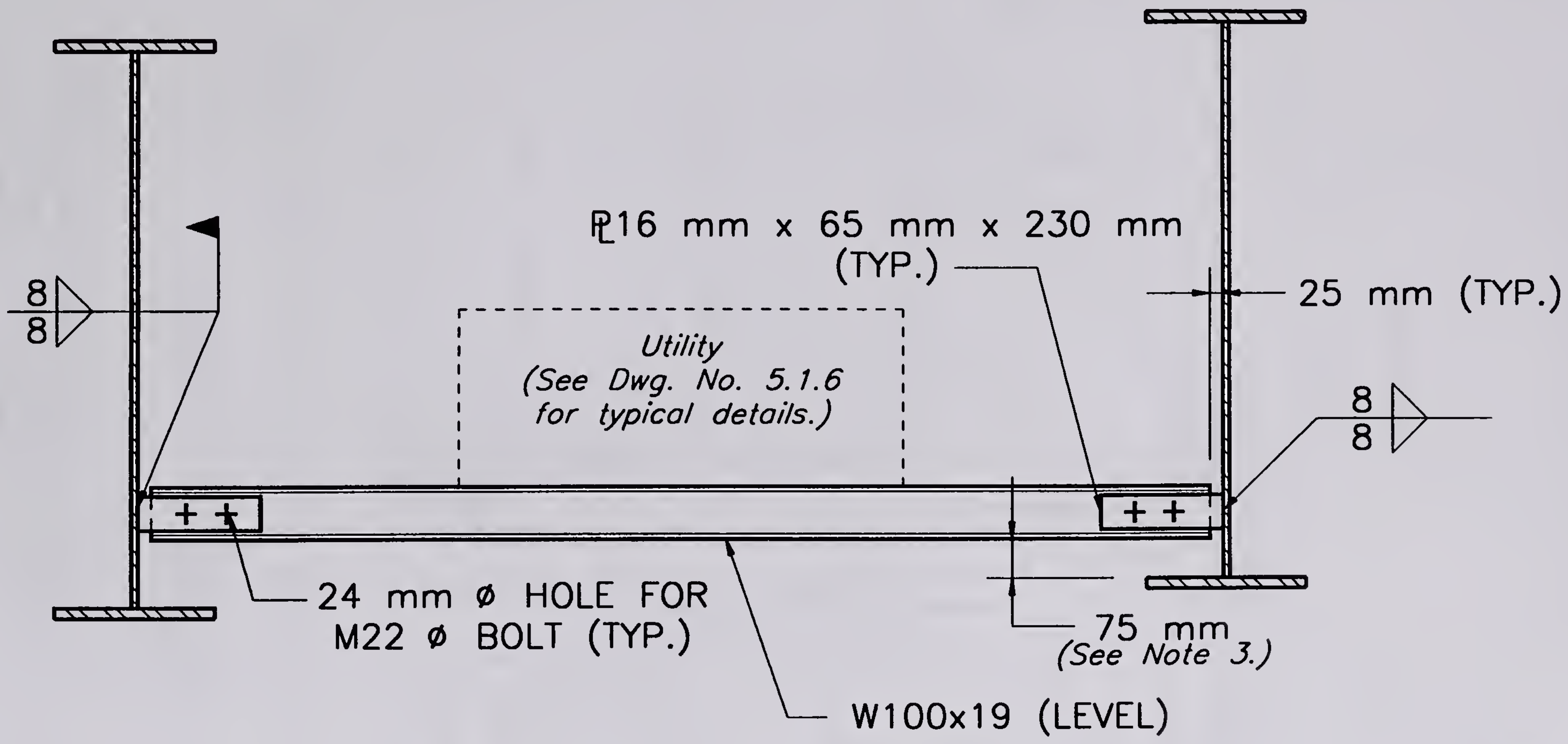
MASS HIGHWAY
BRIDGE
MANUAL

UTILITY SUPPORT DETAILS
AT CROSS FRAMES
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.9

Plot Scale = 1:15


PL16 mm x 65 mm x 230 mm (TYP.)
25 mm (TYP.)
8
8
8
8
Utility
(See Dwg. No. 5.1.6 for typical details.)
24 mm Ø HOLE FOR M22 Ø BOLT (TYP.)
75 mm
(See Note 3.)
W100x19 (LEVEL)

BETWEEN CROSS FRAMES

UTILITY SUPPORT DETAILS

SCALE 1:X

NOTES:

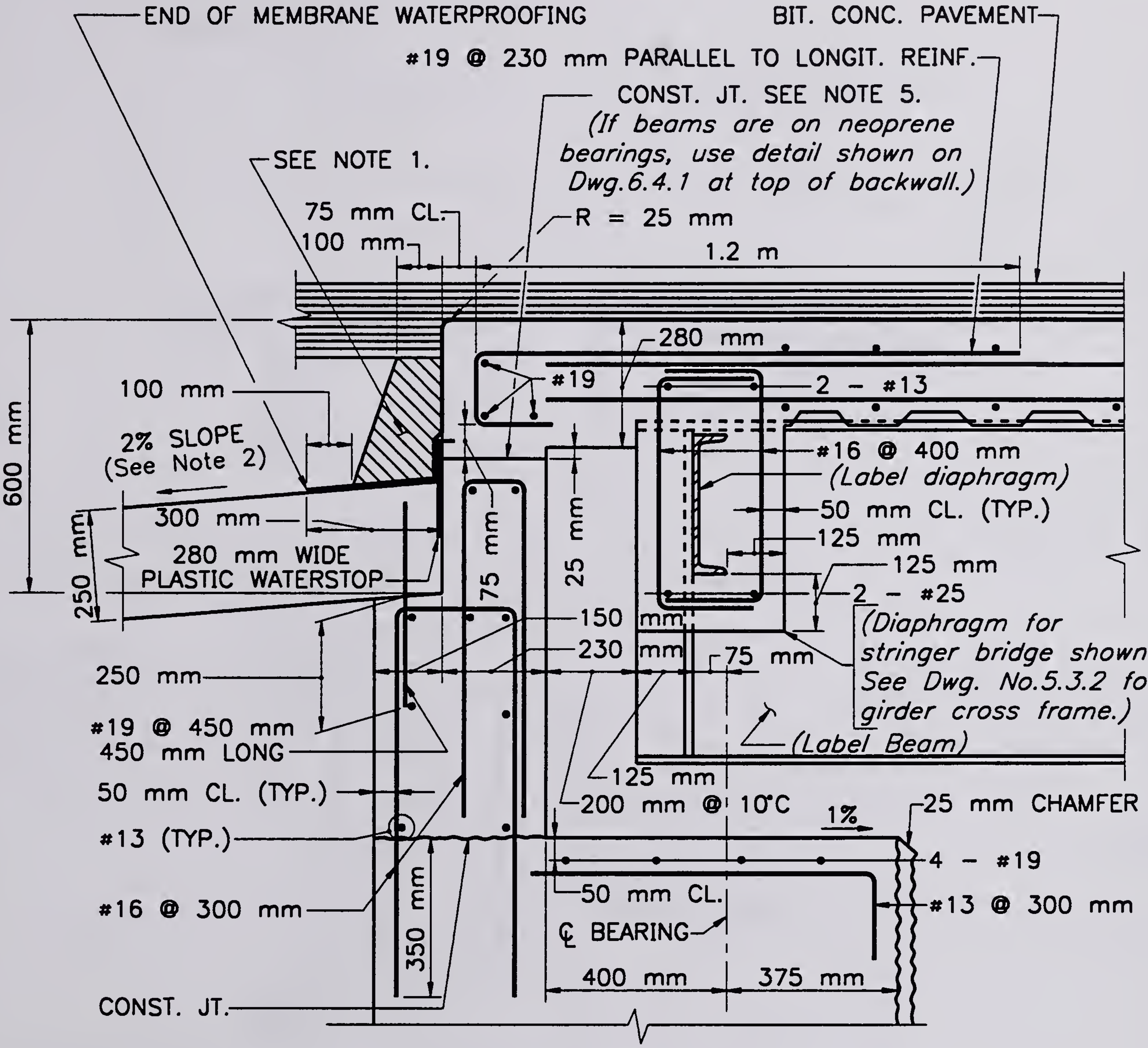
1. The above drawing is not to scale. Modify the details as necessary to suit project.
2. Combine this drawing with the details shown on Dwg. No. 5.2.9.
3. Dimension the location of the support and bolt holes (with edge distances) on this detail. Location of W100x19 shall be compatible with detail of utility supports at intermediate cross frames.

MASS HIGHWAY
BRIDGE MANUAL

UTILITY SUPPORT DETAILS
BETWEEN CROSS FRAMES
PLATE GIRDERS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.2.10



NOTES: *(See Dwg. No.5.3.3 for notes to be included on construction plans.)*

DETAILS AT ABUTMENT – ROADWAY SECTION

SCALE (1:10 min.)

NOTES:

1. *This detail is for fixed bearings up to 36 m, expansion bearings up to 23 m, and skews less than 45° Otherwise, consider Dwg. No. 5.3.2, asphaltic joint, or integral abutment.*
2. *Include and label approach slab reinforcement and show extent of bituminous damp–proofing, for details see Dwg. No. 3.1.12. If approach roadway up–grade is greater than 2%, change slope of approach slab to the approach roadway grade plus 1%.*

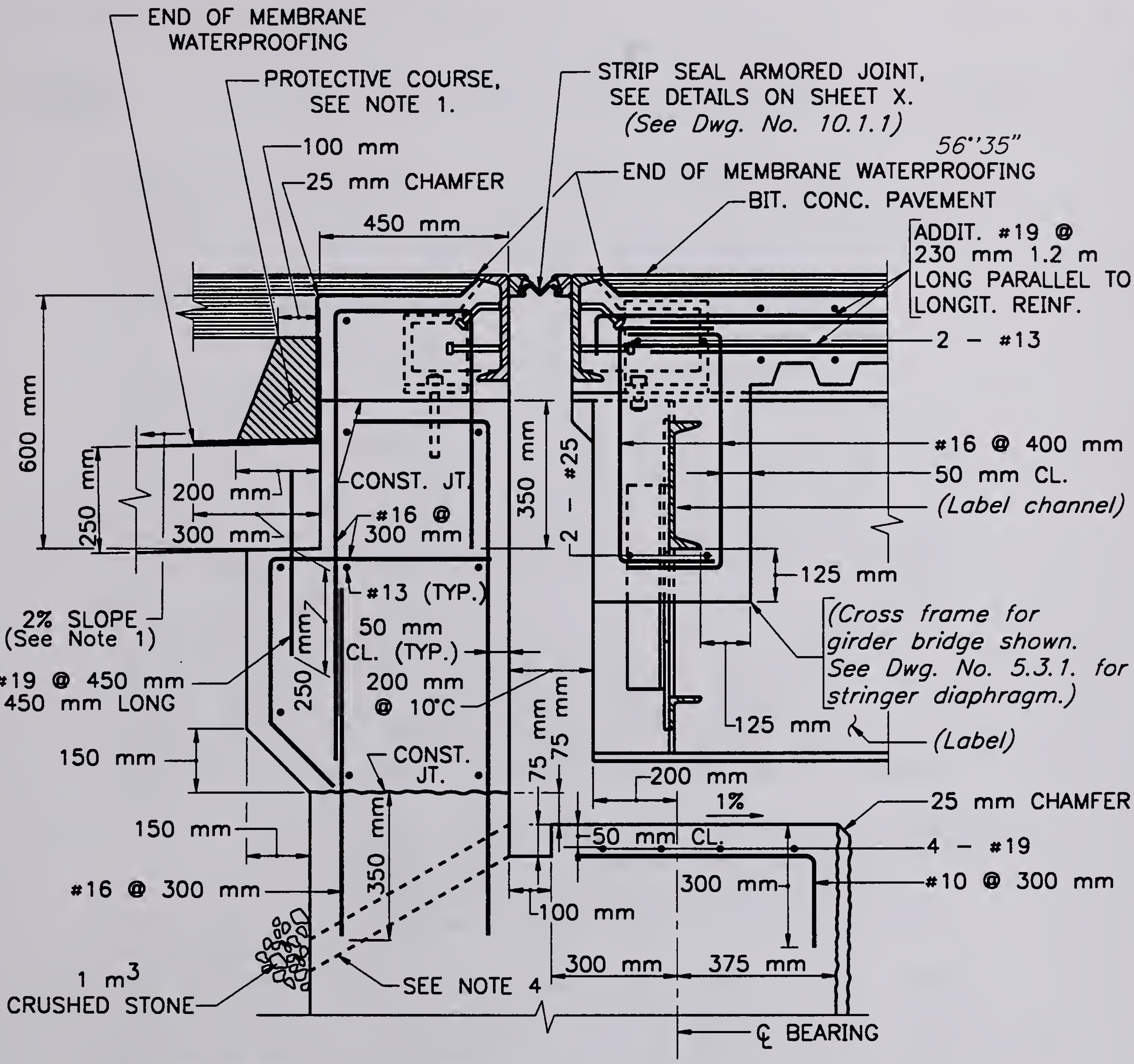
Plot Scale = 1:15

MASS HIGHWAY
BRIDGE
MANUAL

ROADWAY SECTION
(W/O JOINT)
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.3.1



NOTE: *See Dwg. No. 5.3.3 for notes to be included on construction plans.*

DETAILS AT ABUTMENT–ROADWAY SECTION

SCALE (1:10 min.)

NOTES:

1. *Include and label approach slab reinforcement and show extent of bituminous damp-proofing, for details see Dwg. No. 3.1.12. If approach roadway up-grade is greater than 2%, change slope of approach slab to approach roadway grade plus 1%.*
2. *Consider finger joint where movement can't be accomodated by strip seal joint.*

Plot Scale = 1:15

MASS HIGHWAY
BRIDGE
MANUAL

ROADWAY SECTION
(W/ JOINT)
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

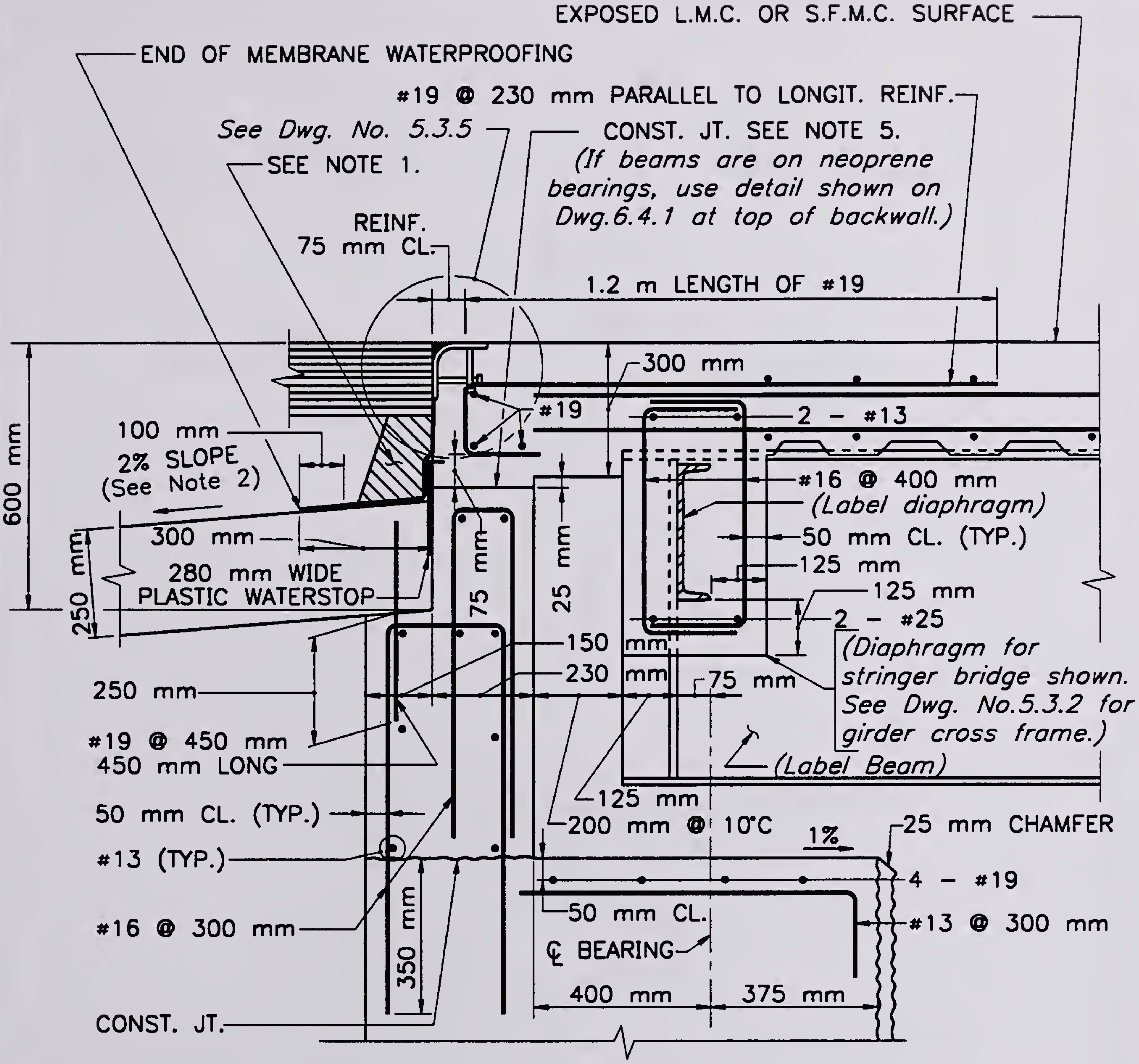
DRAWING NUMBER
5.3.2

NOTES: *(Include these notes with details shown on Dwg. Nos. 5.3.1 & 5.3.2.)*

1. PROTECTIVE COURSE TO BE CLASS I DENSE BINDER COURSE FOR BRIDGES, PLACED IN 50 mm LAYERS AND COMPACTED WITH A MECHANICAL HAND-GUIDED TAMPER WITHIN 12 HOURS AFTER PLACING MEMBRANE WATERPROOFING.
2. ALL REINFORCING SHOWN IN THIS DETAIL SHALL BE EPOXY COATED, EXCEPT FOR APPROACH SLAB REINFORCEMENT.
3. ALL CONCRETE ABOVE CONSTRUCTION JOINT LOCATED AT *(or 75 mm above)* THE BRIDGE SEAT SHALL BE 30 MPa-20 mm-390 kg CEMENT CONCRETE MASONRY. THE CONCRETE BELOW THE BACKWALL AT THE CONSTRUCTION JOINT SHALL BE FINISHED WITH A ROUGHENED SURFACE OF 6 mm AMPLITUDE.
4. PLACE 100 mm ø DRAINS AT EACH END OF TROUGH AND AT LOW POINTS. PLACE 1 m^3 OF CRUSHED STONE BEHIND THE ABUTMENT AT EACH DRAIN.
5. INSIDE FACES OF TROUGH SHALL BE COATED WITH A PROTECTIVE SEAL COAT EMULSION. *(Use this note for details with armored joints.)*
5. TOP OF BACKWALL TO BE TROWELED TO A SMOOTH FINISH, PARALLEL TO PROFILE GRADE. PLACE TWO LAYERS OF TARPAPER ON TOP OF THE BACKWALL AT EXPANSION ENDS ONLY. *(Use this note for details without joints and beams on steel bearings.)*
6. TOP OF BACKWALL TO BE TROWELED TO A SMOOTH FINISH, PARALLEL TO PROFILE GRADE. ELASTOMERIC PAD TO BE EPOXY BONDED TO BACKWALL. *(Use this note for details without joints and beams on neoprene bearings, See Dwg. No. 6.4.1 for details of pad.)*

Plot Scale = 1:1

MASS HIGHWAY BRIDGE MANUAL	CONSTRUCTION NOTES FOR DETAILS AT ABUTMENT ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **5.3.3**



NOTES: *(See Dwg. No.5.3.3 for notes to be included on construction plans.)*

DETAILS AT ABUTMENT – ROADWAY SECTION

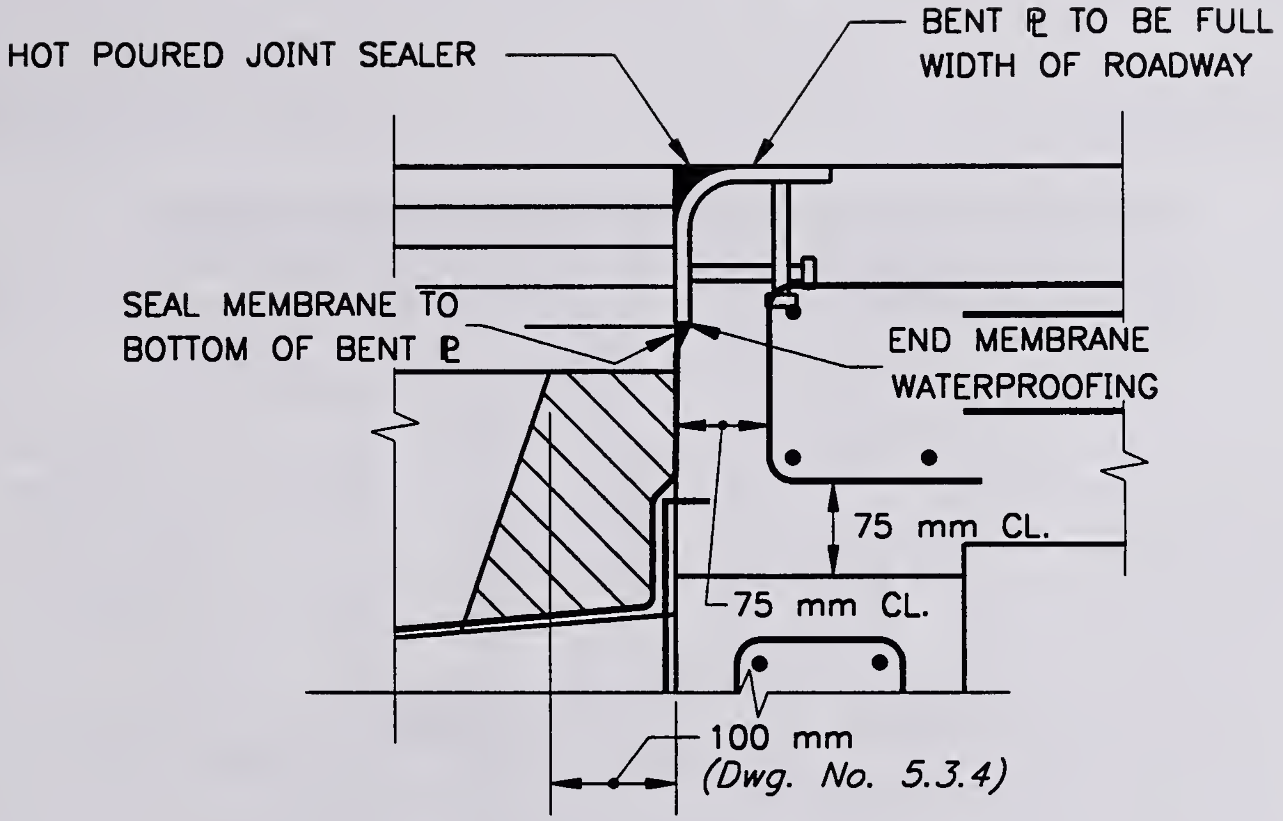
SCALE (1:10 min.)

NOTES:

1. *This detail is for fixed bearings up to 36 m, expansion bearings up to 23 m, and skews less than 45° Otherwise, consider Dwg. No. 5.3.2, asphaltic joint, or integral abutment.*
2. *Include and label approach slab reinforcement and show extent of bituminous damp-proofing, for details see Dwg. No. 3.1.12. If approach raodway up-grade is greater than 2%, change slope of approach slab to the approach roadway grade plus 1%.*

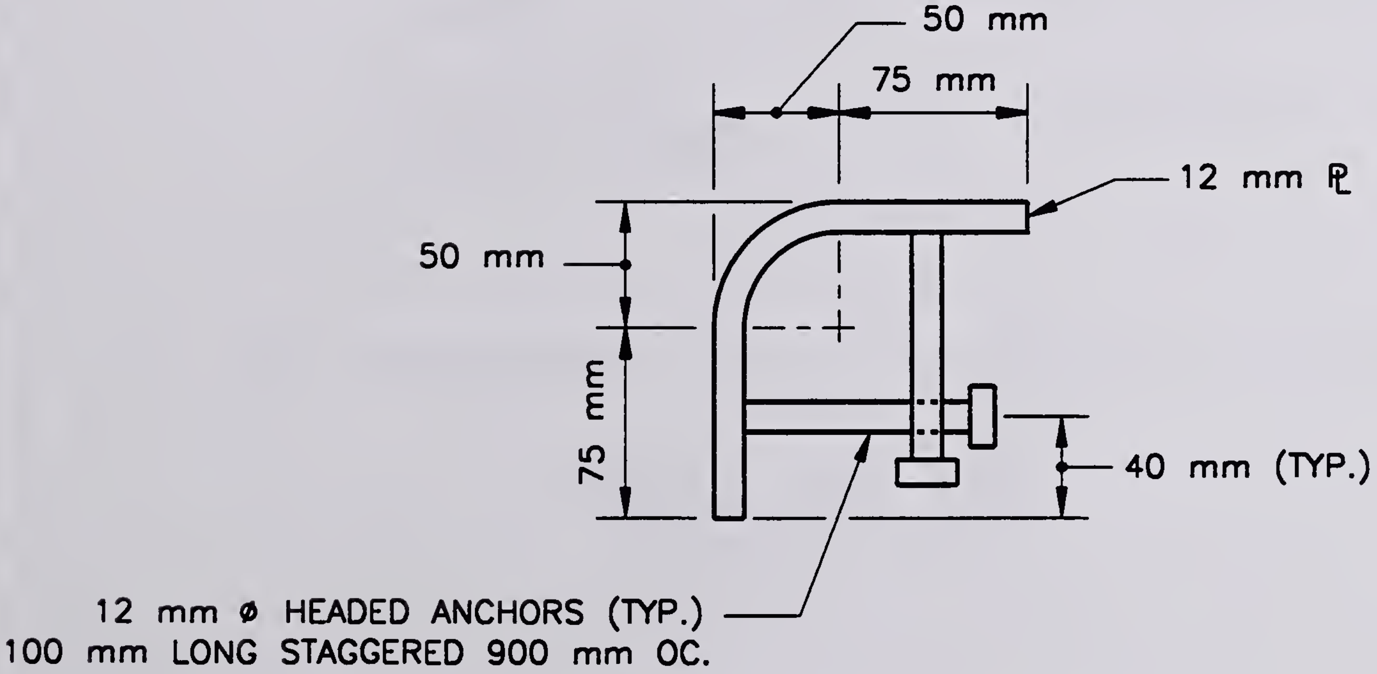
Plot Scale = 1:15

MASS HIGHWAY BRIDGE MANUAL	ROADWAY SECTION (W/O JOINT) FOR EXPOSED DECKS ABUTMENT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **5.3.4**


HOT POURED JOINT SEALER
BENT ⅊ TO BE FULL WIDTH OF ROADWAY
SEAL MEMBRANE TO BOTTOM OF BENT ⅊
END MEMBRANE WATERPROOFING
75 mm CL.
75 mm CL.
100 mm (Dwg. No. 5.3.4)

BENT PLATE DETAIL AT ABUTMENT

SCALE (1:5 min.)


50 mm
75 mm
12 mm ⅊
50 mm
75 mm
40 mm (TYP.)
12 mm ø HEADED ANCHORS (TYP.)
100 mm LONG STAGGERED 900 mm OC.

DETAIL OF BENT PLATE

Scale (1:2.5)

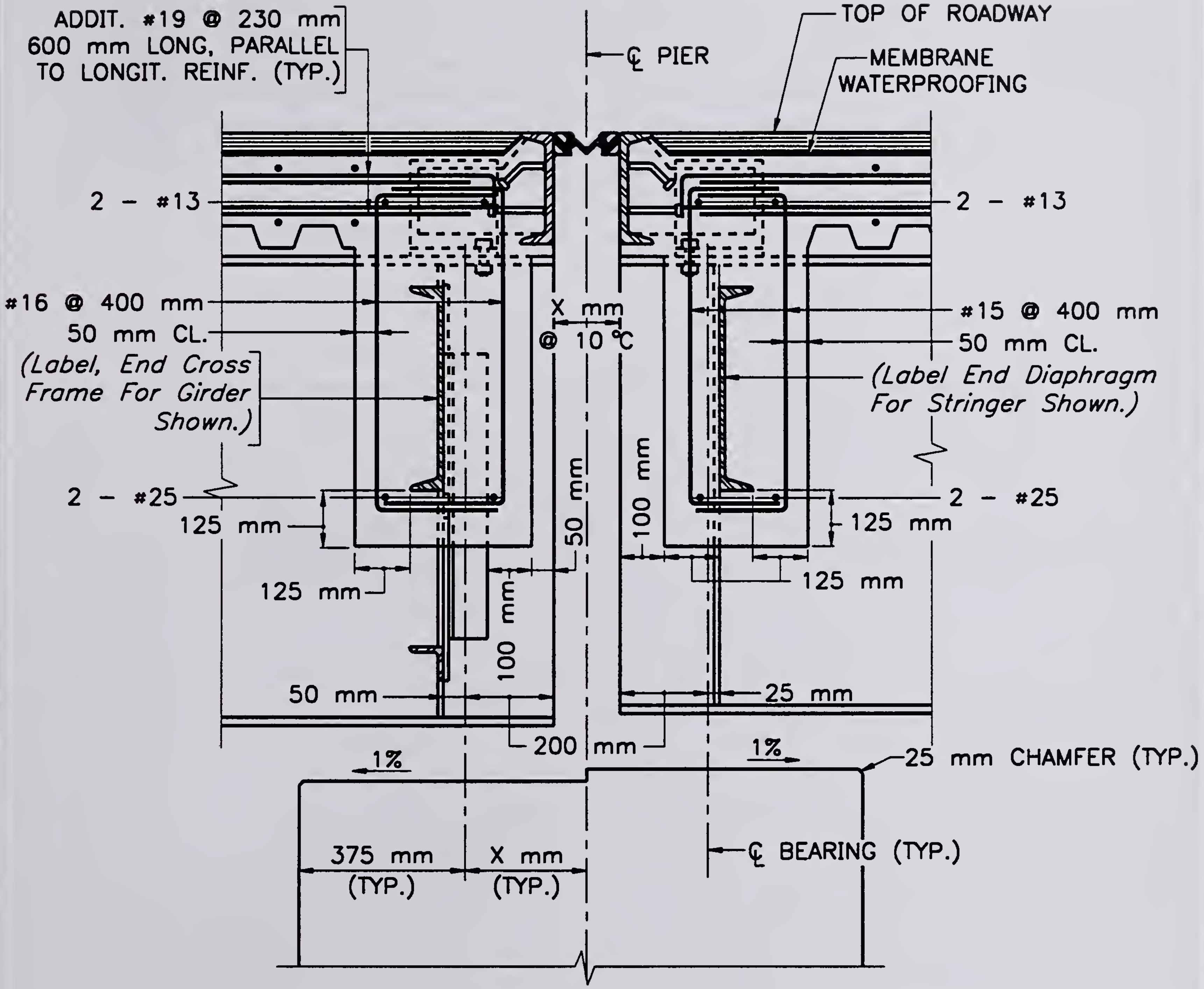
MASSHIGHWAY
BRIDGE
MANUAL

DETAIL OF BENT PLATE AT
ABUTMENT FOR EXPOSED DECKS
ABUTMENT DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.3.5

Plot Scale = 1:15



NOTE: REINFORCEMENT IN PIER CAP HAS BEEN OMITTED FOR CLARITY.

DETAILS OVER PIER

SCALE (1:10 min.)

Plot Scale = 1:15

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL ROADWAY SECTION
FOR JOINT AT PIER
PIER DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.4.1

NOTES:

1. *The minimum theoretical camber shall be shown on the construction plans by either a camber diagram or table of cambers.*
2. *The camber of a single span beam or girder shall be specified by the ordinate at the mid-length of the segment to be curved. However, for a continuous structure, provide as many additional points as necessary to define the camber.*
3. *In the calculation for the minimum theoretical camber, do not include camber tolerances. Do not show tolerances on the construction plans.*
4. *The minimum theoretical camber shall be a sum of the following values:*
    X = 100% Dead Load Deflection
    Y = Middle Ordinate of the Vertical Curve
    Z = Residual Camber (from the table below)

RESIDUAL CAMBER: *(for every 3 m of span length)*

Grade	*Single Simple Span*	*Multiple Simple Spans & Continuous Spans*
VERT. CURVE	2 mm PER 3 m	0
STRAIGHT	4 mm PER 3 m	2 mm PER 3 m

Plot Scale = 1:1

MASS HIGHWAY
BRIDGE
MANUAL

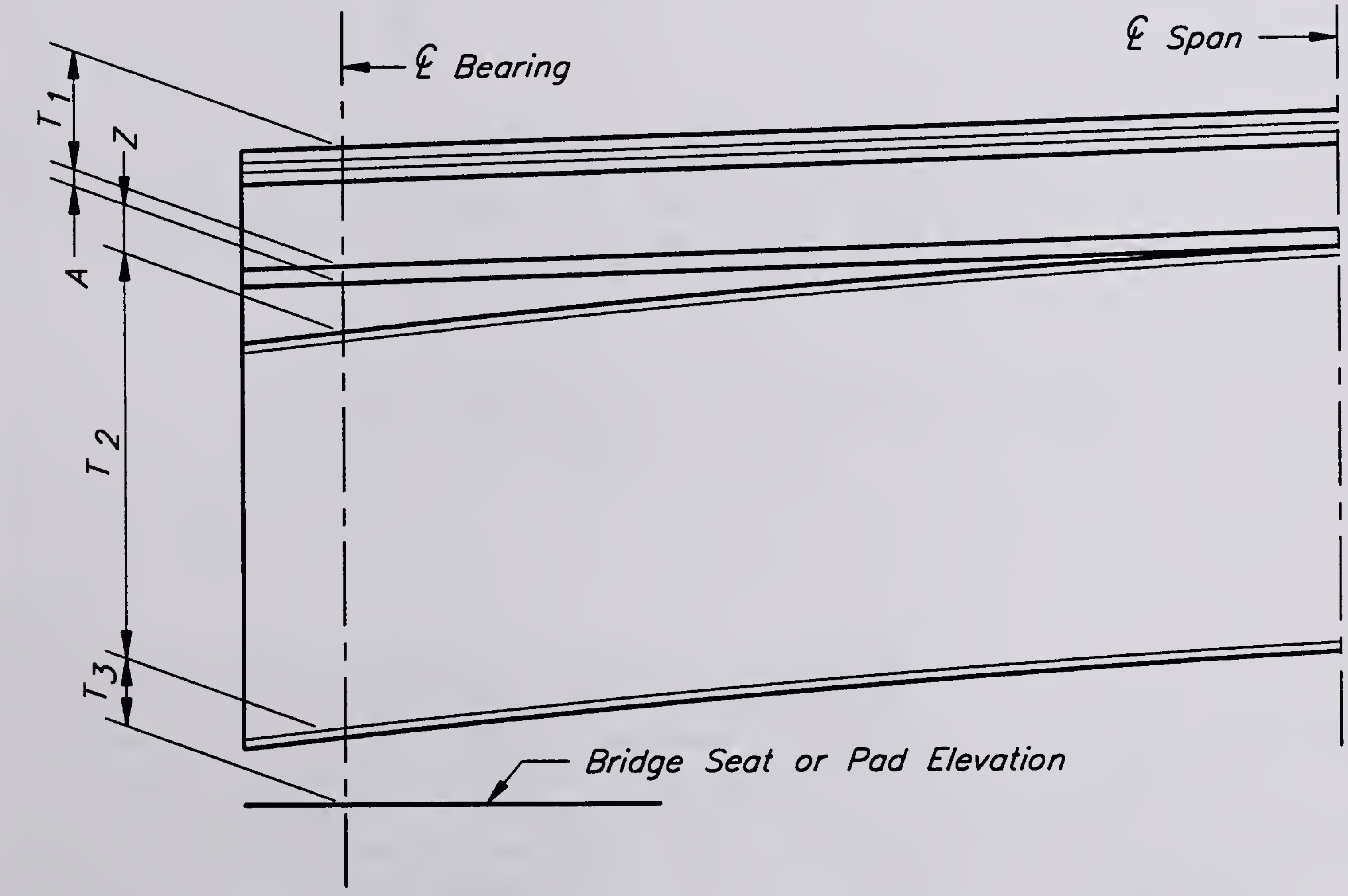
CAMBER
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.5.1

NOTES:

1. Bridge Seat Elevation is determined by the following:
   Roadway Elev. − (T_1 + T_2 + T_3 + A + Z), where
   T_1 = Wearing Surface + Slab Thickness
   T_2 = Depth of Stringer or Girder
   T_3 = Depth of Bearing
   A = Blocking Distance at maximum camber (See Dwg. No. 7.1.10.)
   Z = Residual Camber (See Dwg. No. 5.5.1.)
2. For a negative vertical curve, the middle ordinate of the curve should also be subtracted from the roadway elevation to get Bridge Seat Elevation.



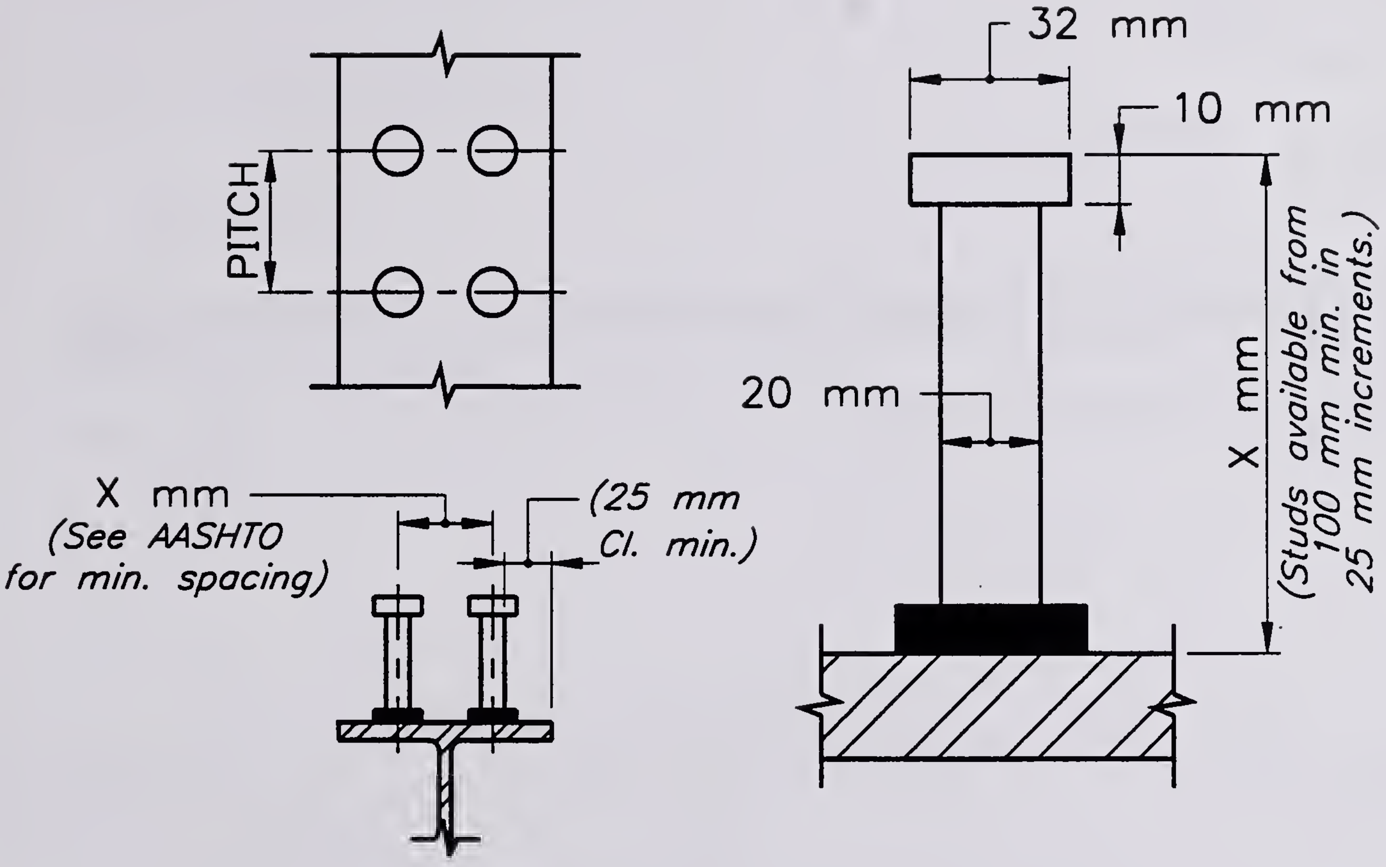
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

BRIDGE SEAT ELEVATIONS
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.5.2


32 mm
10 mm
PITCH
20 mm
X mm
(Studs available from 100 mm min. in 25 mm increments.)
X mm
(See AASHTO for min. spacing)
(25 mm Cl. min.)

NOTE: 22 mm Ø STUDS MAY BE SUBSTITUTED FOR 20 mm Ø STUDS BY ADJUSTING THE PITCH TO PROVIDE AN EQUIVALENT CROSS-SECTIONAL AREA PER FOOT.

STUD SHEAR CONNECTORS

NOT TO SCALE

NOTES:

1. *All shear connectors shall be designed according to the current edition of the AASHTO Standard Specifications for Highway Bridges.*
2. *In the case where the beam haunch exceeds 150 mm, the AASHTO embedment provisions may not be met. The plane between the deck slab and haunch shall be checked for shear resistance. If additional resistance is required, stirrups shall be designed across the plane rather than lengthening the stud connectors.*
3. *The pitch of the studs need not be made in multiples of the spacing of transverse steel reinforcement in the deck slab; however, the studs alignment shall be that of the transverse reinforcement.*
4. *The minimum pitch shall be as specified in AASHTO, the maximum pitch shall be 600 mm. Indicate the stud spacing on the construction plans on the beam elevation views.*

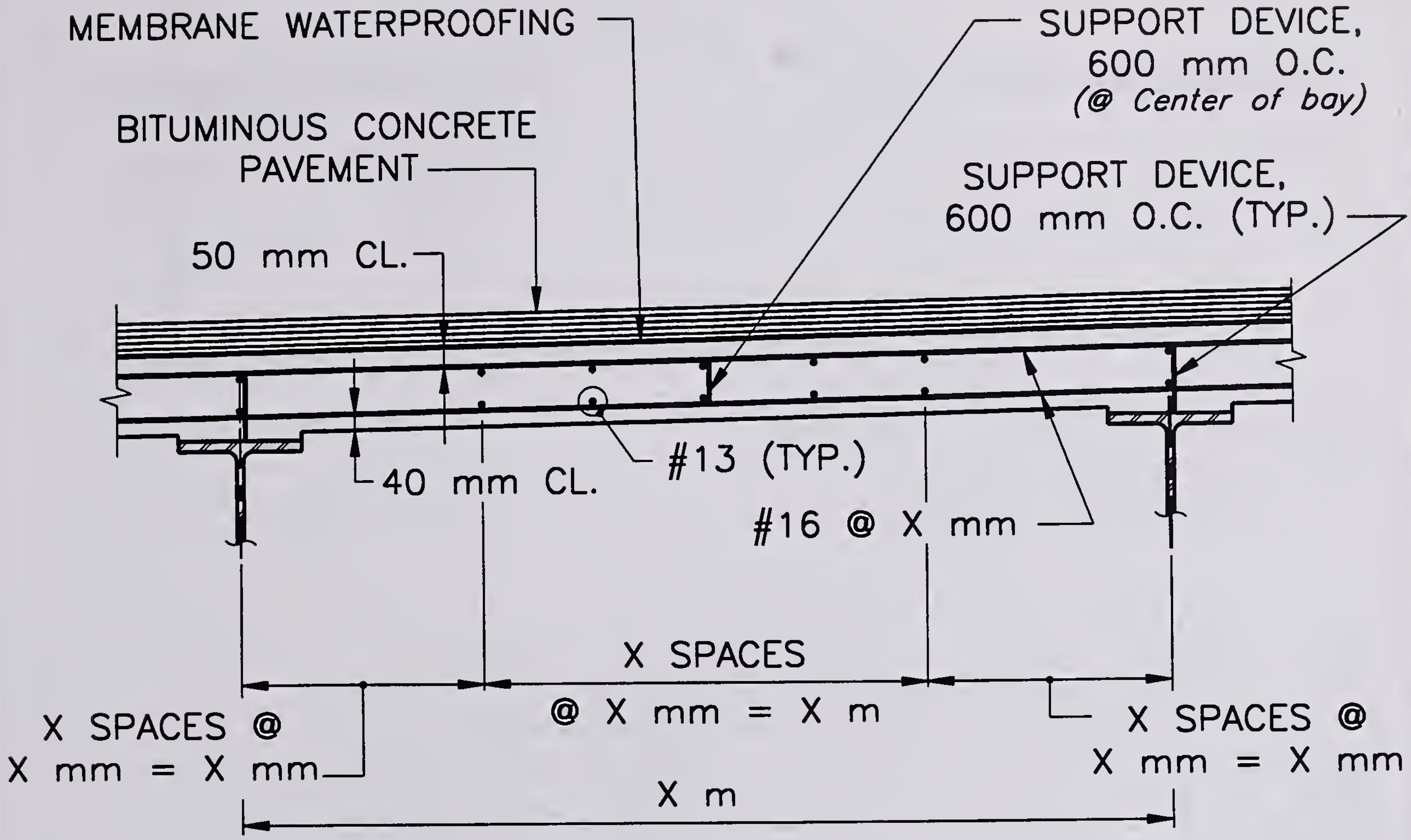
Plot Scale = 1:5

MASS HIGHWAY
BRIDGE
MANUAL

SHEAR CONNECTORS
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
5.5.3



NOTES:

1. ROADWAY DECK SLAB SHALL BE 30 MPa–20 mm–390 kg CEMENT CONCRETE MASONRY.
2. #13 LONGITUDINAL REINFORCEMENT SHALL BE PLACED PARALLEL TO THE ℄ OF CONSTRUCTION.
3. #16 MAIN REINFORCEMENT SHALL BE PLACED PARALLEL TO THE ABUTMENTS. *(Modify as required.)* SUPPORT DEVICES SHALL BE EPOXY COATED.

TYPICAL DECK REINFORCEMENT

SCALE (1:20 min)

NOTES:

1. *Modify the above drawing as required when stay–in–place forms and/or L.M.C. overlayment is used.*
2. *Slabs which are over salt water and within 900 mm of mean high water shall have a 75 mm cover over the bottom steel.*
3. *See Dwg. No. 7.1.2 for design of main reinforcement.*
   See Dwg. No. 7.1.3 for design of distribution reinforcement.
4. *For decks continuous over piers, show deck reinforcement at piers.*

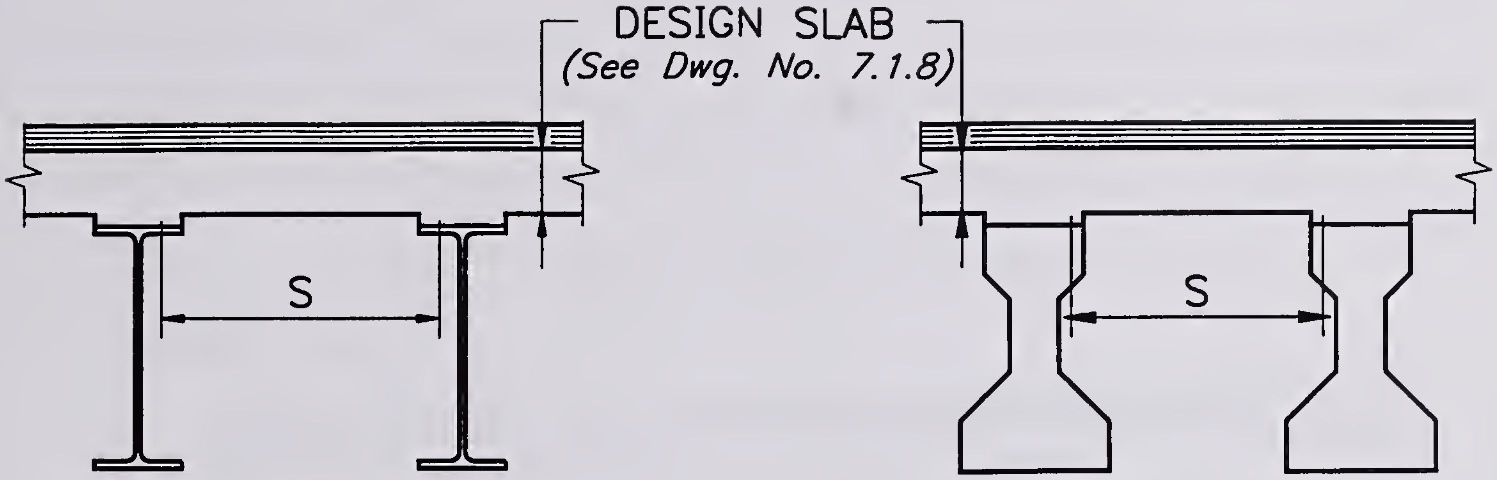
Plot Scale = 1:20

MASSHIGHWAY
BRIDGE MANUAL

TYPICAL DECK REINFORCEMENT
GENERAL DECK DETAILS

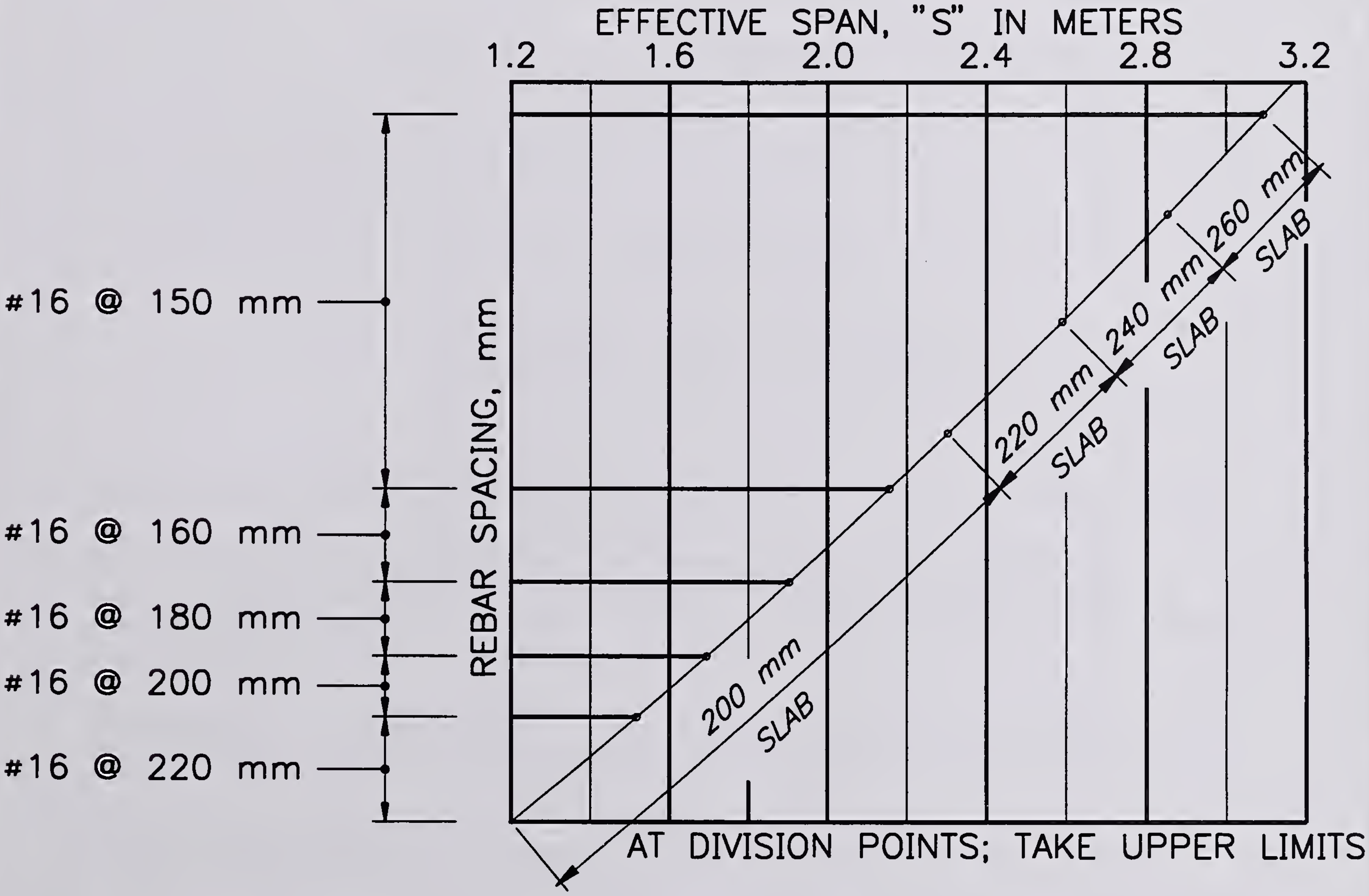
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.1



STEEL STRINGER BEAM SECTION

PRESTRESSED CONCRETE BEAM SECTION



NOTES:

1. *S = Effective Span Length, the distance between edges of flanges plus half the stringer flange.*
2. *Span is to be measured in the direction of the main reinforcement. All main steel is to be placed normal to the line of traffic.*
3. *Distribution steel is to be placed parallel to the center line of construction.*
4. *Deck reinforcement shall conform to AASHTO M 31M, Grade 400.*

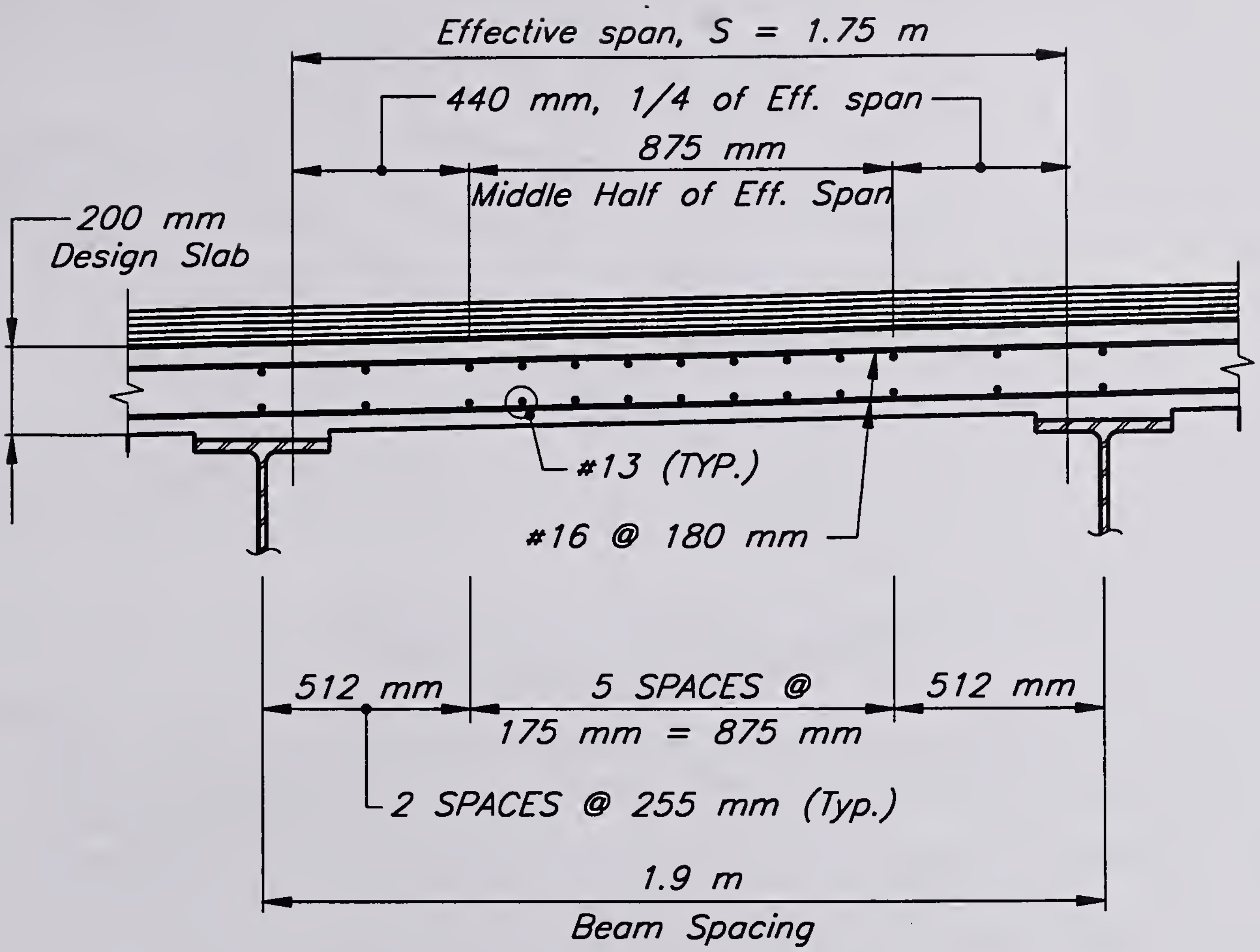
Plot Scale = 1:1

MASSHIGHWAY
BRIDGE
MANUAL

DESIGN OF MAIN
REINFORCEMENT
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.2



EXAMPLE CALCULATION

1. *Example: Beam Spacing = 1.9 m, Flange Width = 300 mm, skew > 25°.*
2. *From Dwg. No. 7.1.2, Main Slab Reinforcement = #16 @ 180 mm, area of main steel per meter = number of bars per meter x area of one bar (Area = 1000 mm/m ÷ 180 mm x 199 mm*^{2} *= 1105.6 mm*^{2}*/m) and effective span, S = 1.75 m.*
3. *% distribution steel for middle half of effective span =* $121 \div \sqrt{S} = 121 \div \sqrt{1.75}$ *= 91%. However, maximum allowable percentage is 67%.*
4. *Total area of distribution steel in middle half of effective span = S ÷ 2 x 67% of Main Reinforcement = 1.75 ÷ 2 x .67 x 1105.6 = 648.2 mm*^{2}*.*
5. *Spacing of distribution steel in middle half of effective span = S ÷ 2 x (Area of one bar ÷ Total Required Area) = 1.75 ÷ 2 x 129 ÷ 648.2 = 0.174 m.*
6. *Use #13 @ 175 mm in middle half of effective span.*
7. *The spacing of the reinforcement in the outer 1/4 strips shall not exceed twice the reinforcement of the middle half, use #13 @ 255 mm.*
8. *The above steps meet the AASHTO requirement for distribution steel.*

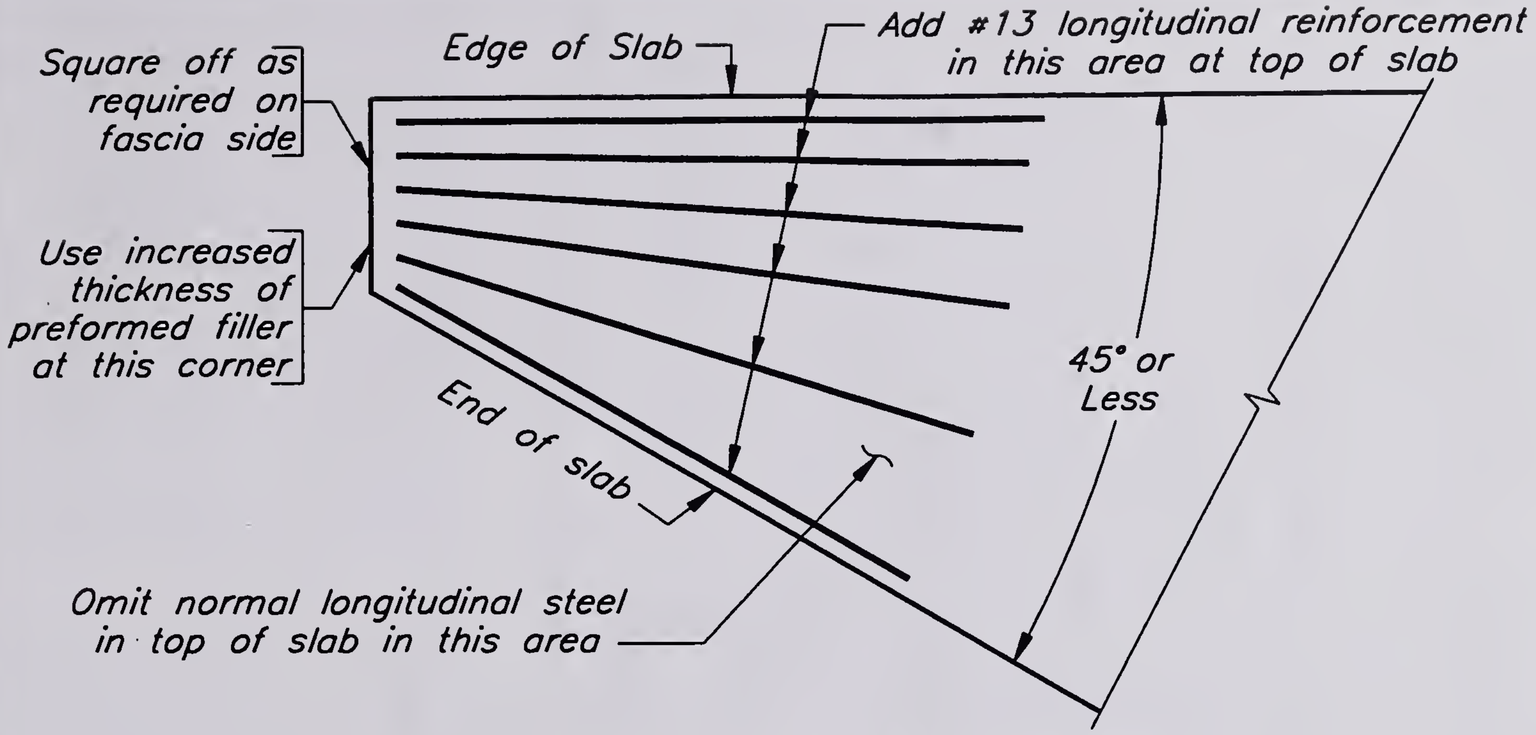
PLOT SCALE 1:20

MASSHIGHWAY
BRIDGE
MANUAL

DESIGN OF DISTRIBUTION
REINFORCEMENT
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.3

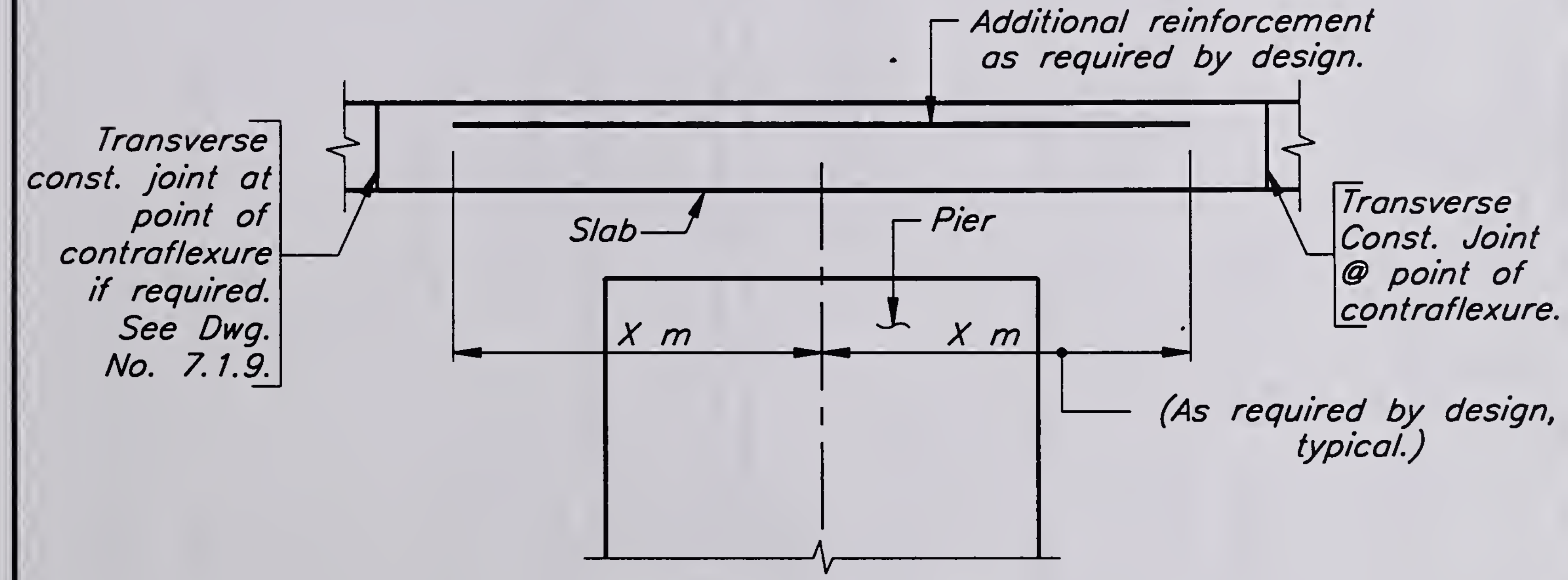

Square off as required on fascia side
Edge of Slab
Add #13 longitudinal reinforcement in this area at top of slab
Use increased thickness of preformed filler at this corner
45° or Less
End of slab
Omit normal longitudinal steel in top of slab in this area

PLAN AT ACUTE CORNER

NOT TO SCALE

NOTES:

1. Slabs having acute corners 45° or less will have additional reinforcement placed in top of slab. Details will be shown on the contract plans.
2. Investigate into the adjustment of bearing to provide for lateral expansion.
3. Provide for fanning of reinforcement in sidewalk sections when main steel is perpendicular to curb line.


Additional reinforcement as required by design.
Transverse const. joint at point of contraflexure if required. See Dwg. No. 7.1.9.
Slab
Pier
Transverse Const. Joint @ point of contraflexure.
X m
X m
(As required by design, typical.)

SECTION AT PIER

NOT TO SCALE

NOTE:

Deck slabs of continuous spans over piers will have additional reinforcement placed in top of slab. Details will be shown on the contract plans. If bars larger than # 16 are used for this reinforcement, the Designer shall check the clearances between the reinforcing mats.

Plot Scale = 1:20

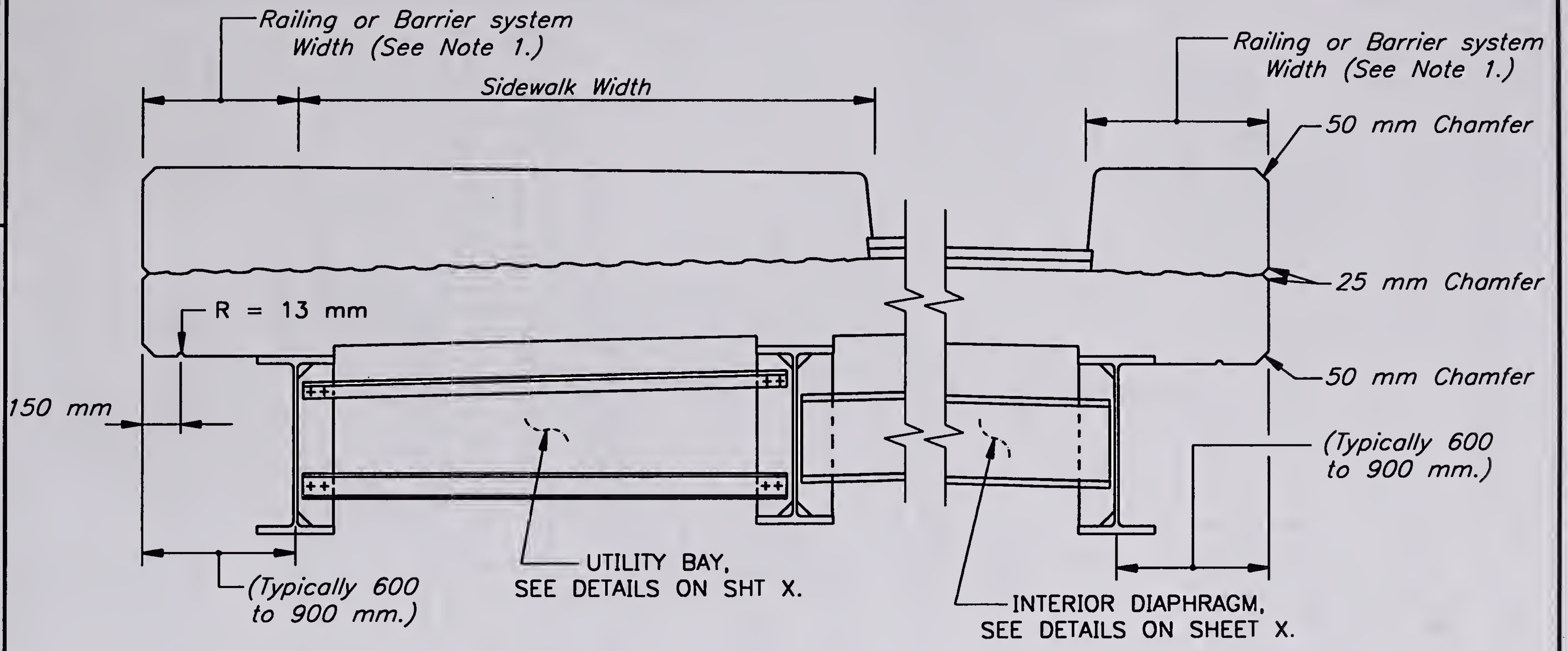
MASS HIGHWAY
BRIDGE
MANUAL

ADDITIONAL REINFORCEMENT
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.4

Plot Scale = 1:25


Railing or Barrier system Width (See Note 1.)
Sidewalk Width
R = 13 mm
150 mm
(Typically 600 to 900 mm.)
UTILITY BAY, SEE DETAILS ON SHT X.
INTERIOR DIAPHRAGM, SEE DETAILS ON SHEET X.
Railing or Barrier system Width (See Note 1.)
50 mm Chamfer
25 mm Chamfer
50 mm Chamfer
(Typically 600 to 900 mm.)

NOTES:

1. SIDEWALK AND SAFETY CURB CONCRETE SHALL BE 35 MPa–20 mm–385 kg SILICA FUME MODIFIED CEMENT CONCRETE MASONRY.
2. TRANSVERSE STEEL IN SIDEWALK AND SAFETY CURB SHALL FOLLOW THE SAME DIRECTION AS THE TRANSVERSE DECK STEEL. *(Modify as required.)*

SIDEWALK SECTION

SAFETY CURB SECTION

NOTES:

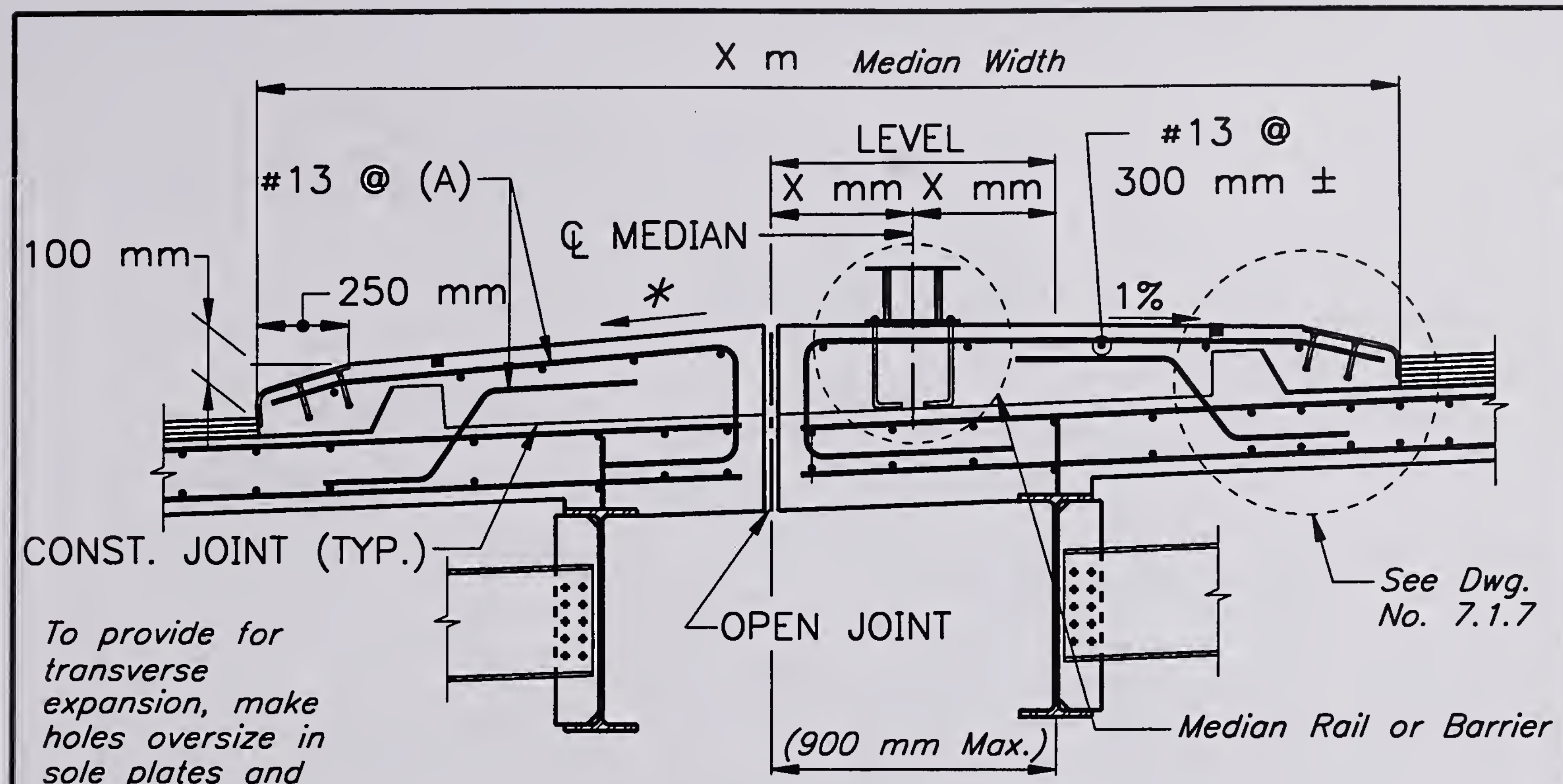
1. *See Chapter 9, Railing/Traffic Barrier Systems, for the sidewalk and safety curb details of the appropriate railing for the dimensions, reinforcement, and embedment lengths not shown here. Include the above notes to the details in Chapter 9 or the Transverse Cross–Section.*
2. *Above drawing is not to scale.*
3. *Steel stringer bridge shown. Details for steel girder or separated box beams are similar.*
4. *See Dwg. No. 7.1.3 for longitudinal deck reinforcement layout.*

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL SIDEWALK AND SAFETY
CURB DETAILS
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

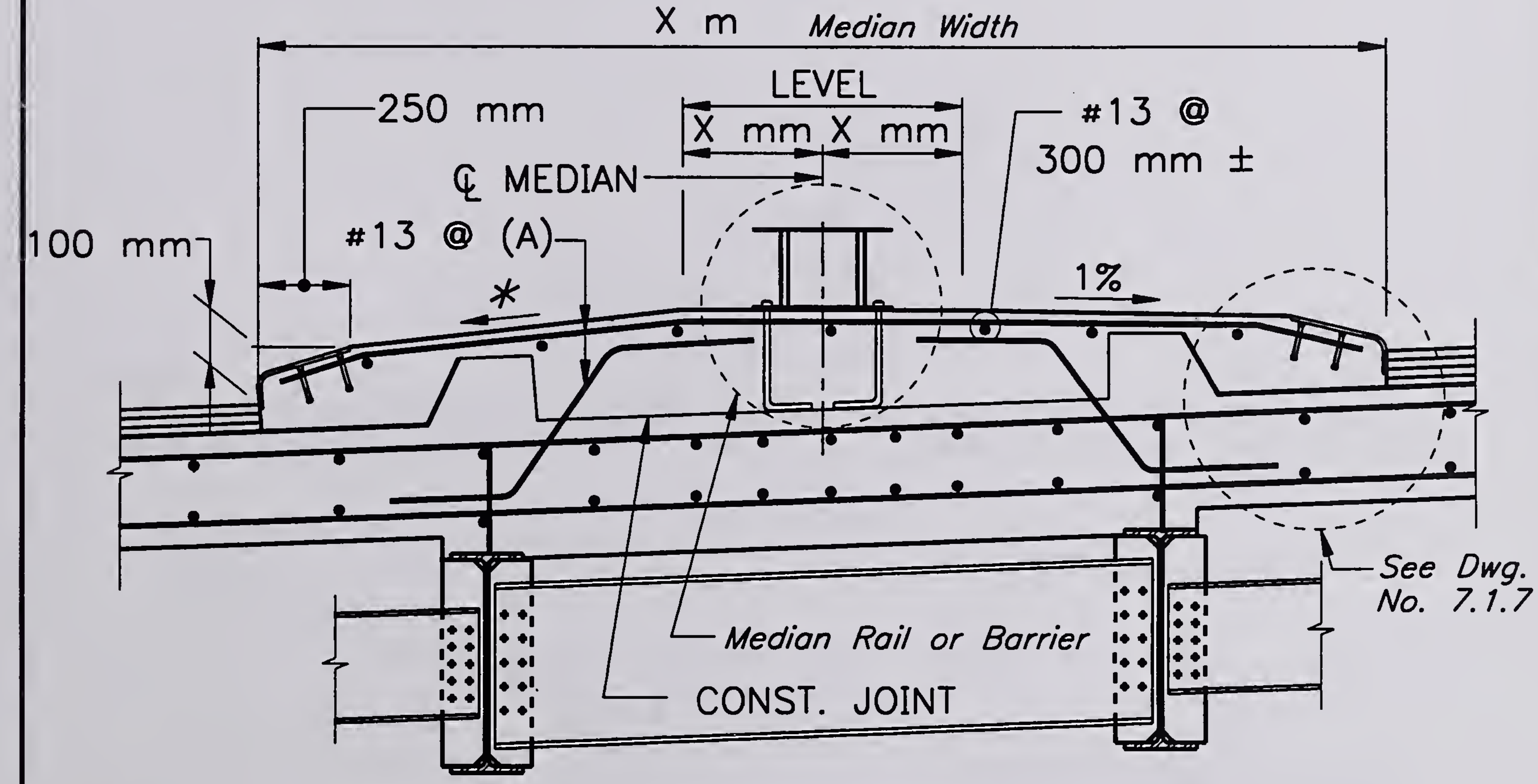
DRAWING NUMBER
7.1.5



To provide for transverse expansion, make holes oversize in sole plates and stringers at expansion and fixed bearings.

WITH EXPANSION JOINT

(To be used only where total width of bridge exceeds 21 m)



** 1% min., slope to suit.*

WITHOUT EXPANSION JOINT

MEDIAN DETAILS

SCALE (1:10 min.)

NOTES:

1. *Above drawings are not to scale.*
2. *A = twice the spacing of main slab reinforcement.*
3. *Details for separated precast beams are similar.*

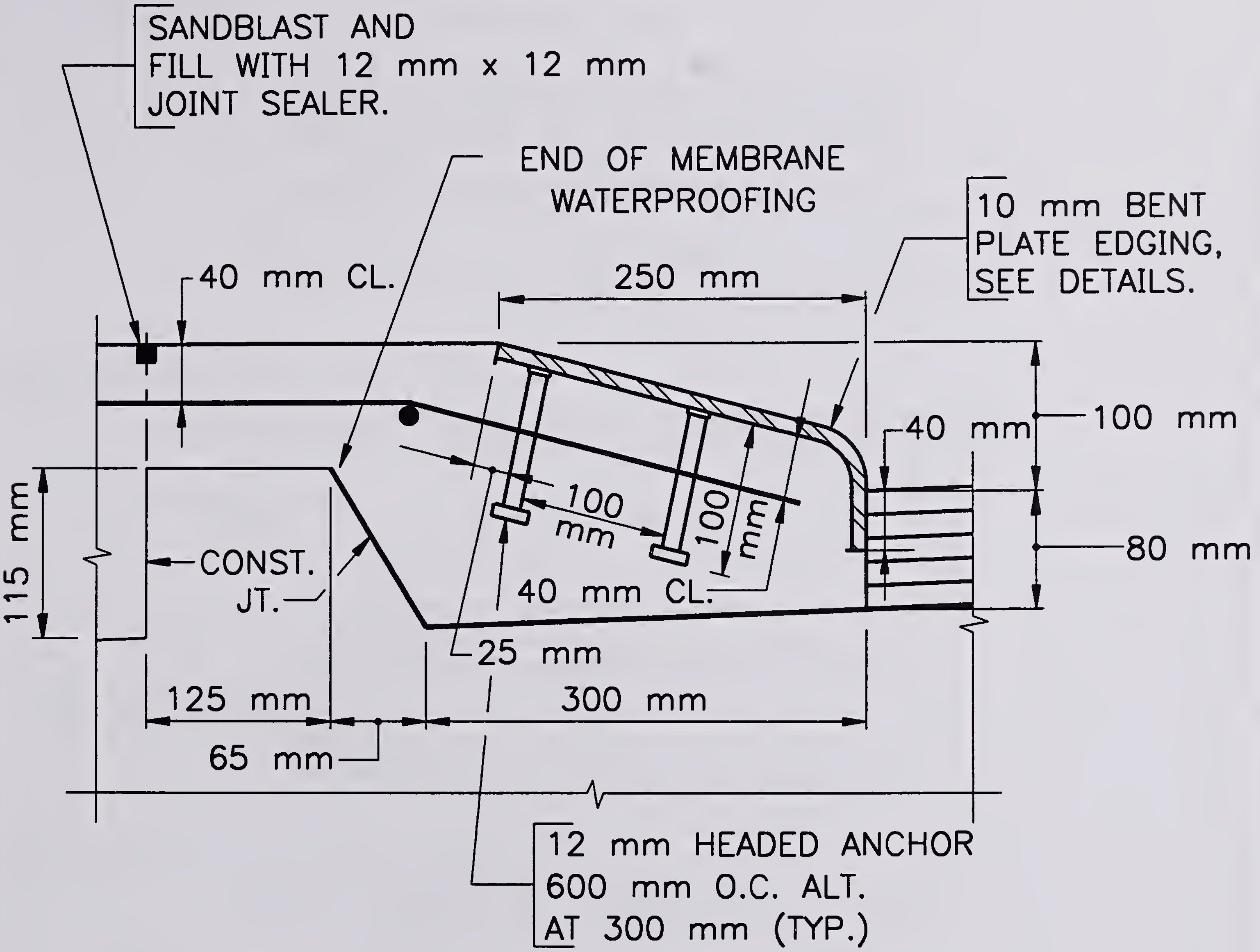
Plot Scale 1:15

MASS HIGHWAY
BRIDGE
MANUAL

MEDIAN DETAILS
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.6

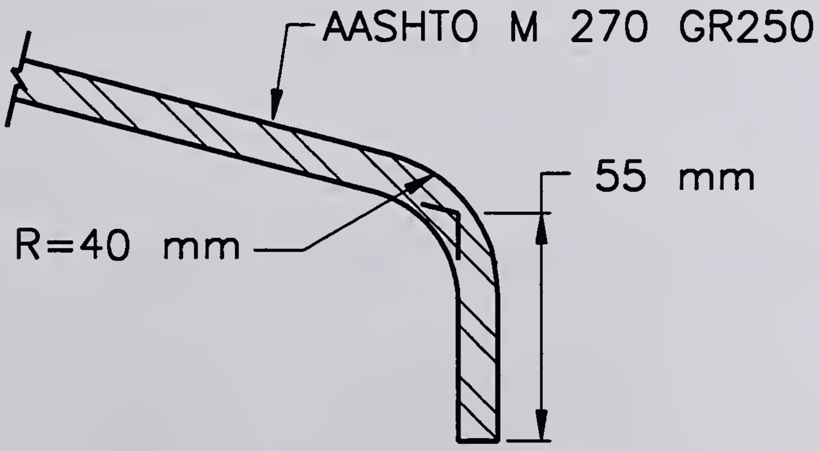


MEDIAN CURB DETAIL

SCALE 1:5

NOTE:

For L.M.C. overlayment, substitute the concrete pour under the bent plate to the joint sealer with L.M.C. and use 75 mm instead 100 mm headed anchors.



BENDING DETAIL

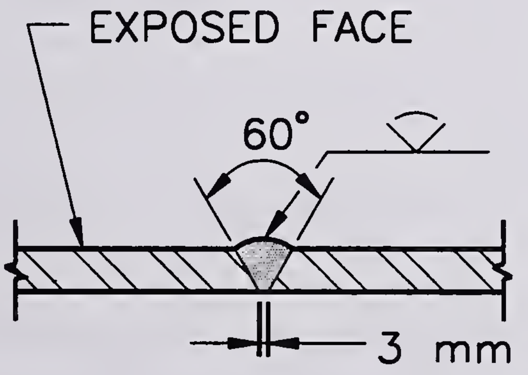


PLATE SPLICE

BENT PLATE EDGING DETAILS

NOT TO SCALE

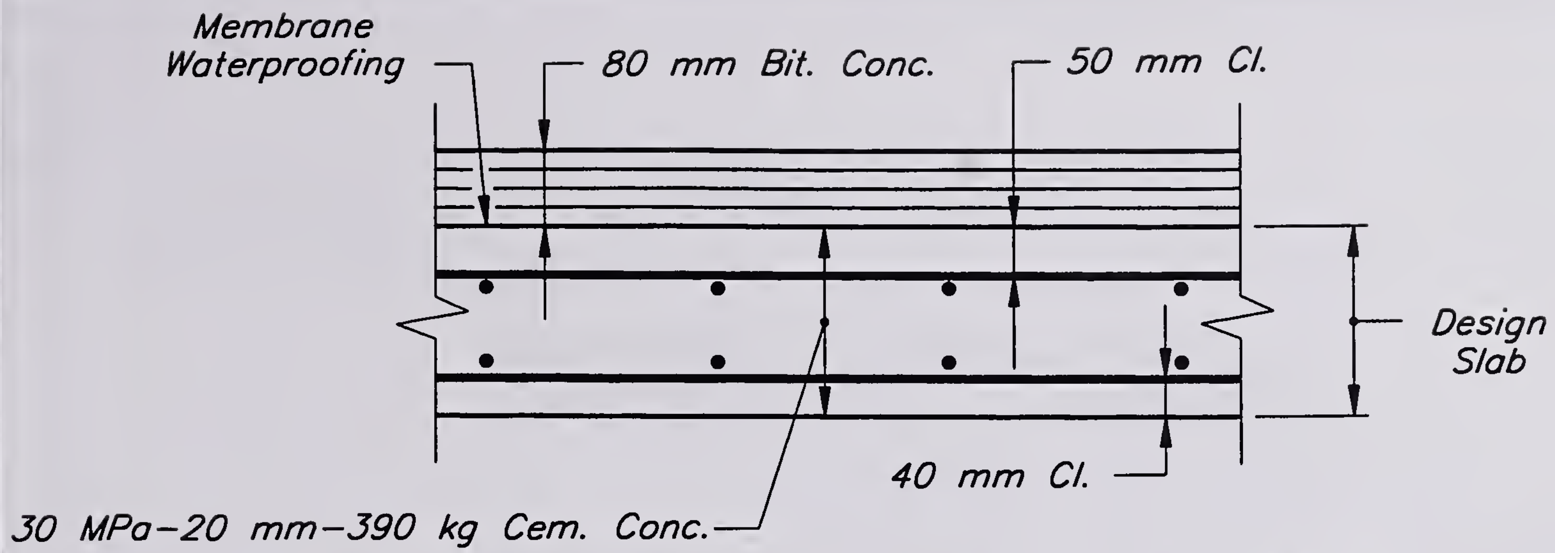
Plot Scale = 1:5

MASS HIGHWAY
BRIDGE
MANUAL

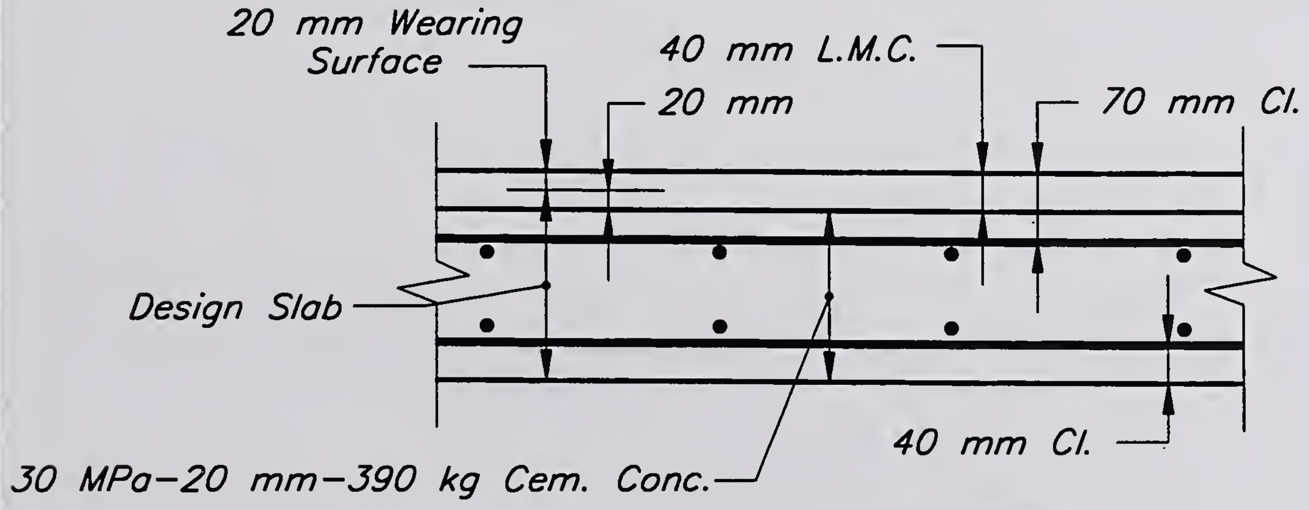
MEDIAN CURB DETAILS
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

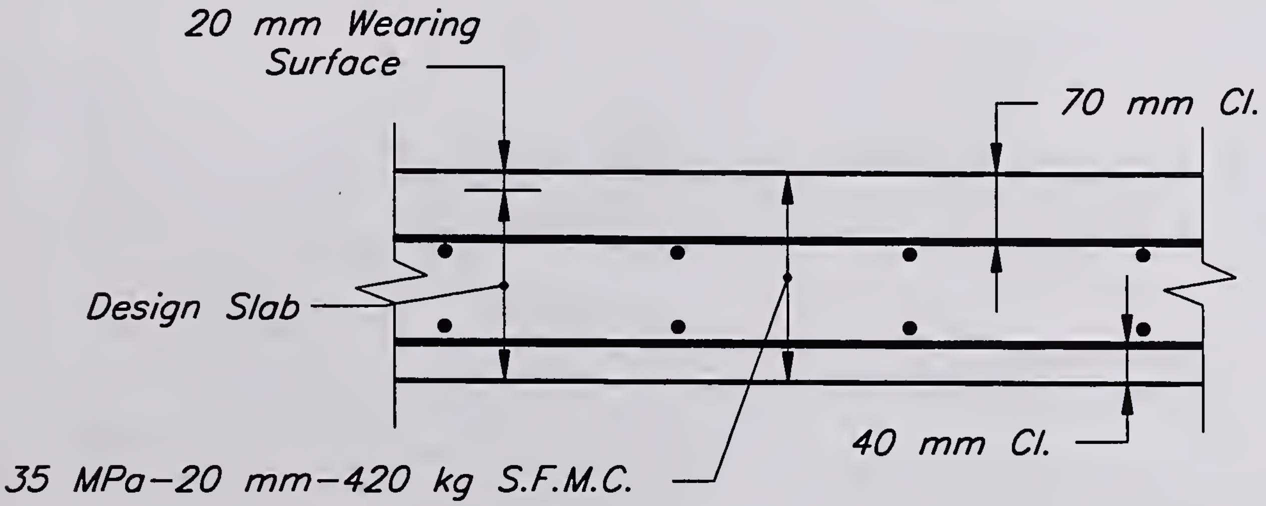
DRAWING NUMBER
7.1.7



BITUMINOUS CONCRETE WEARING SURFACE



LATEX MODIFIED CONCRETE – L.M.C.



SILICA FUME MODIFIED CONCRETE – S.F.M.C.

NOTES:

1. Bituminous Concrete wearing surface shall be placed on bridges only when the profile is less than 4%.
2. When the profile grade is greater than 4% or when special conditions may warrant the designer shall select a wearing surface and protective system other than bituminous concrete. The bridge engineer should be consulted in this selection.
3. A 40 mm L.M.C. or S.F.M.C. wearing surface alone shall not be used over precast butted beam bridges.
4. Above drawings are not to scale.

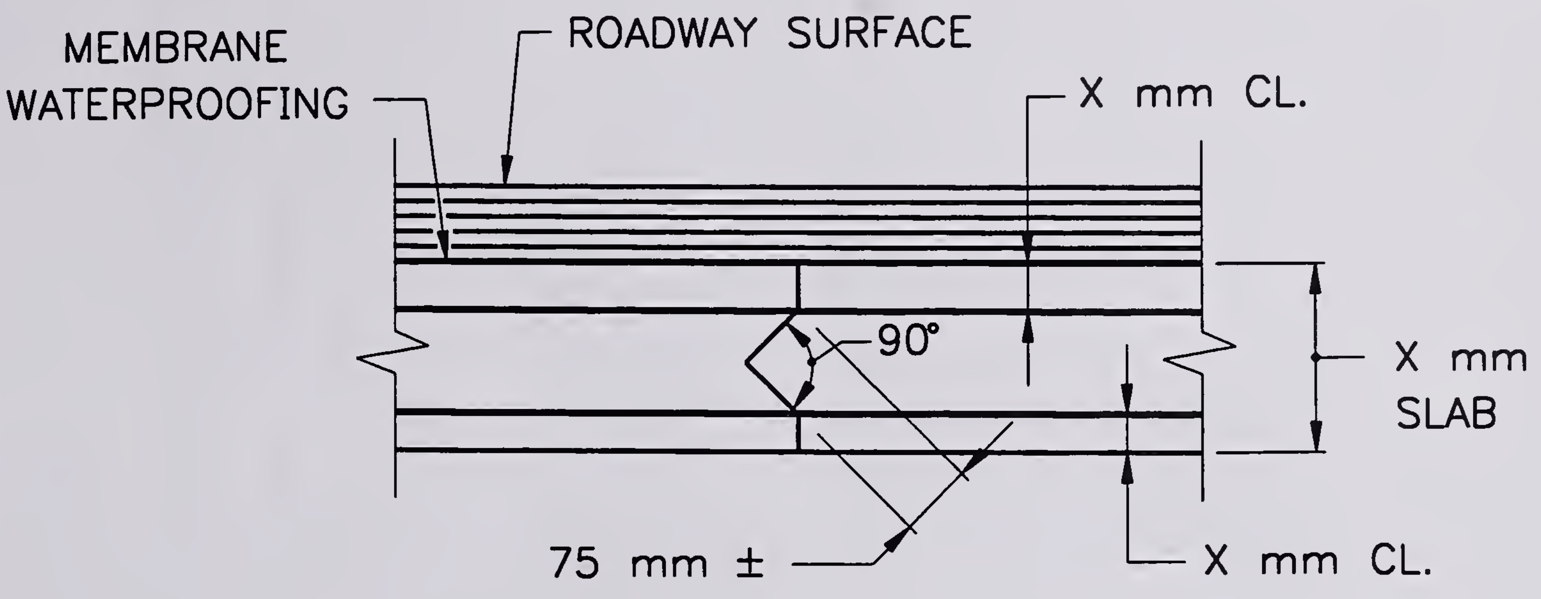
MASS HIGHWAY
BRIDGE MANUAL

BRIDGE DECK
WEARING SURFACES
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.8

Plot Scale = 1:10



LONGITUDINAL (*or transverse*) CONSTRUCTION JOINT DETAIL IN DECK SLAB

SCALE (1:10 min.)

NOTES:

1. *When practical all concrete bridge deck placement shall be continuous over the full width and length of the structure or superstructure unit.*
2. *If the above is not feasible, the following shall be shown on the construction drawings;*
   - *A) Details of the deck joints.*
   - *B) Location of the longitudinal joints (1/4 point between stringers).*
   - *C) Location of the transverse joints on continuous structures (At the dead load point of contraflexure).*
3. *The design engineer shall check the volume of concrete to be placed for the bridge deck superstructure. Continuous pouring sequences requiring more than 210 m^3 of concrete are generally not considered practical and should be broken with construction joints. Continuous pouring sequences requiring simultaneous placement of more than 420 m^3 with more than one finishing machine are also not considered practical and should be broken with construction joints.*
4. *If construction joints are required, then a 24 hour curing period shall be observed between subsequent pours and a 3 day curing period observed if concrete previously placed was in a negative moment region of a continuous structure. Note the curing period on the construction plans.*

Plot Scale = 1:10

MASS HIGHWAY
BRIDGE MANUAL

CONSTRUCTION JOINTS
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.9

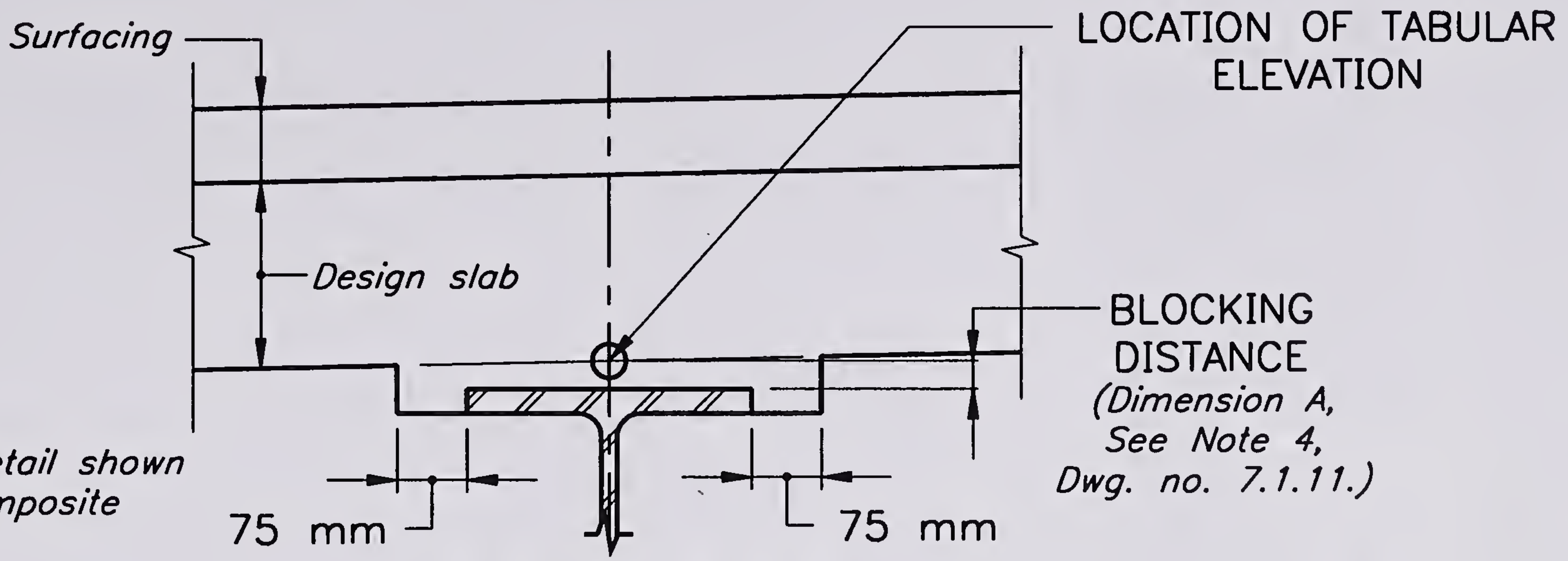
Plot Scale = 1:10

TOP OF FORM ELEVATIONS FOR DECK SLAB PRIOR TO PLACEMENT OF CONCRETE

BEAM NO.	INCREASING STATIONS ⟶								
	℄ BRG.	1/8 PT.	1/4 PT.	3/8 PT.	1/2 PT.	5/8 PT.	3/4 PT.	7/8 PT.	℄ BRG.

NOTE:

AFTER THE BEAMS ARE ERECTED BUT BEFORE THE FORMS ARE BUILT, ELEVATIONS ON THE TOP OF THE FLANGE OF THE BEAMS ARE TO BE OBTAINED AT THE POINTS INDICATED IN THE TABLE. THE DIFFERENCE BETWEEN THE ELEVATIONS OBTAINED AND THOSE SHOWN IN THE TABLE GIVES THE ACTUAL BLOCKING DISTANCE FROM THE TOP OF BEAM TO THE BOTTOM OF SLAB AT CENTER LINE OF BEAM.


Surfacing
Design slab
LOCATION OF TABULAR ELEVATION
BLOCKING DISTANCE (Dimension A, See Note 4, Dwg. no. 7.1.11.)
75 mm
75 mm

NOTE: *The haunch detail shown is for non composite construction.*

HAUNCH DETAIL

TOP OF FORM DETAILS

NOT TO SCALE

MASSHIGHWAY
BRIDGE
MANUAL

TOP OF FORM DETAILS
GENERAL DECK DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.10

NOTES:

1. The Top of Form Elevation Table and Haunch Detail shall appear on the construction plans. For stay-in-place forms, the haunch detail shall be modified appropriately and include the applicable notes. (See Section 7.2)
2. For spans of 15 m and less, elevations are to be shown at 1/4 points only.
3. The tabular elevations shall be calculated by taking the proposed finished grade of the centerline of beams and:
   A. Subtracting the surfacing and concrete slab thickness and
   B. Adding the theoretical deflection of the beams due to the weight of the slab, surfacing, and all other superimposed dead loads.
4. At the point of maximum camber, dimension A shall be 25 mm for spans up to 15 m and 40 mm for spans over 15 m. Use dimension A for the computation of bridge seat elevations but do not show on the construction plans. Dimension A shall be considered as 0 mm when calculating the physical properties of composite beams, however, the weight of the haunch shall be included in the design calculations.

Plot Scale = 1:1

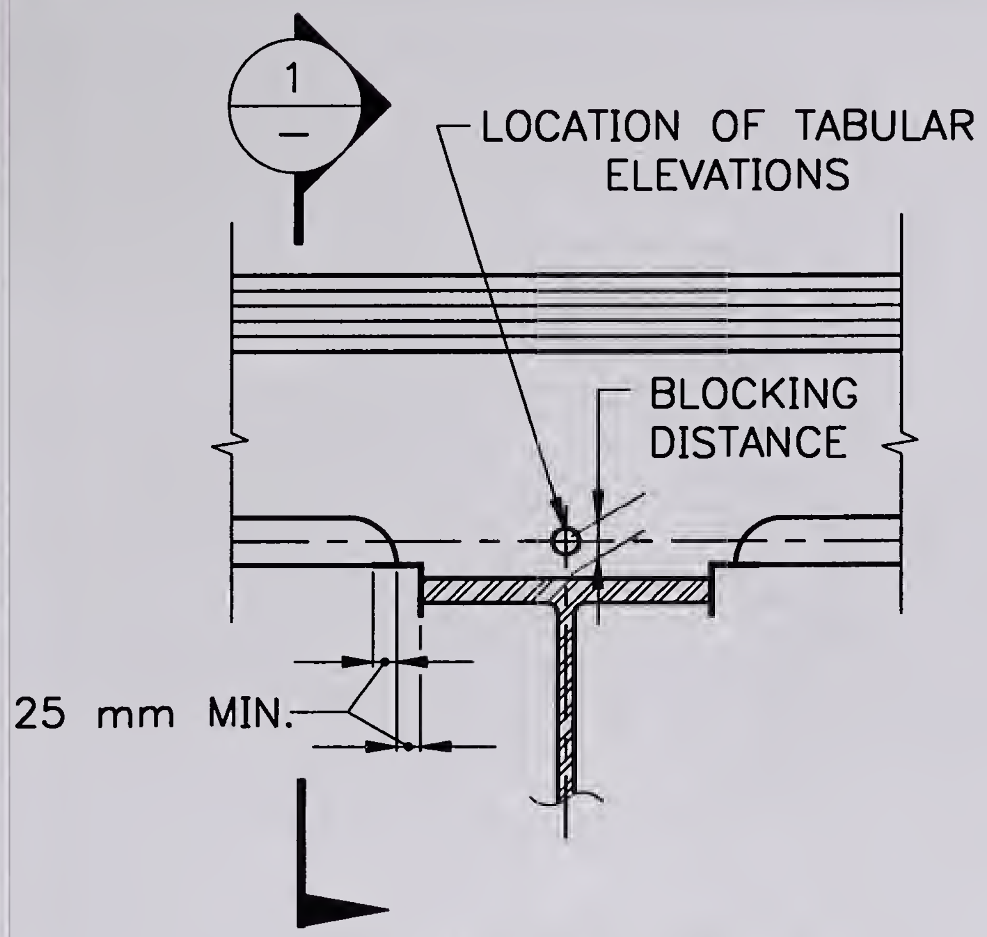
MASSHIGHWAY
BRIDGE
MANUAL

DESIGNER NOTES FOR
TOP OF FORMS
GENERAL DECK DETAILS

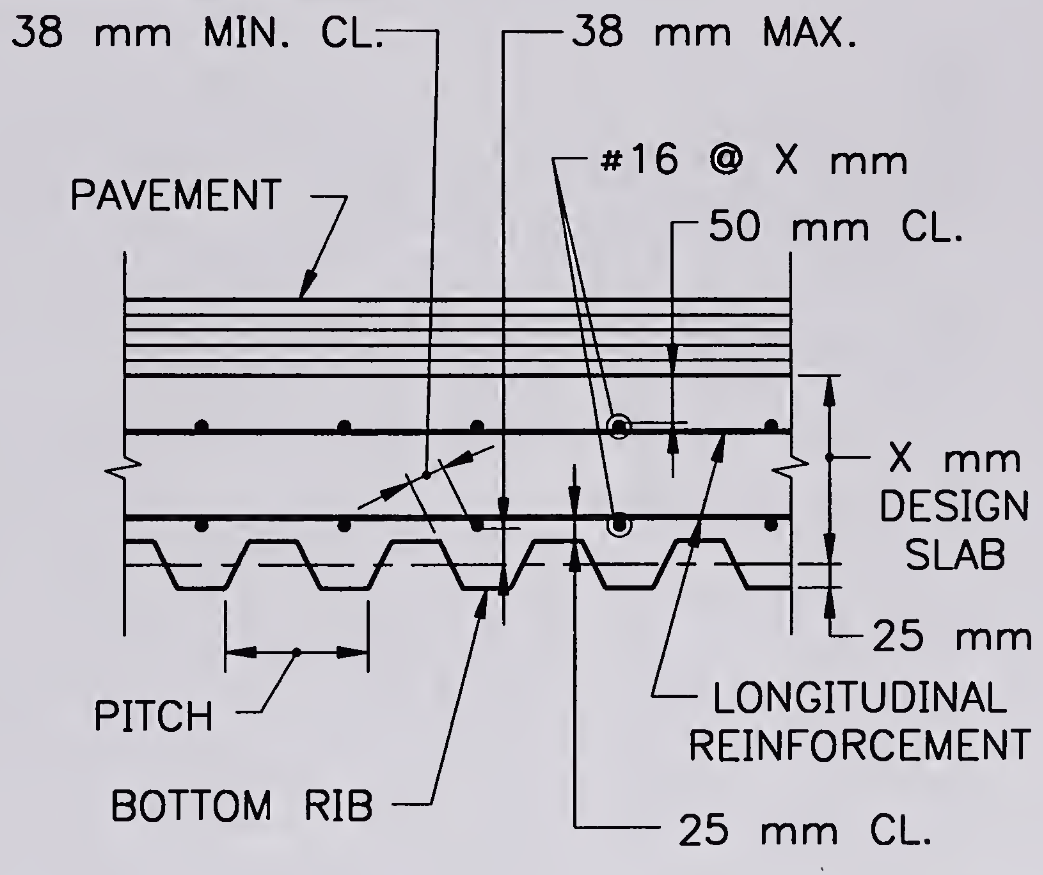
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.1.11

Plot Scale = 1:10



HAUNCH DETAIL



SECTION 1

NOTE: *(See Dwg. No. 7.2.2 for construction notes to be added here.)*

STAY–IN–PLACE FORM DETAILS

NOT TO SCALE

NOTE: Adjust the above drawings as necessary for L.M.C. overlayment.

MASSHIGHWAY
BRIDGE
MANUAL

DETAILS
STAY–IN–PLACE FORMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.2.1

NOTES: *(Include these notes with details shown on dwg. No. 7.2.1)*

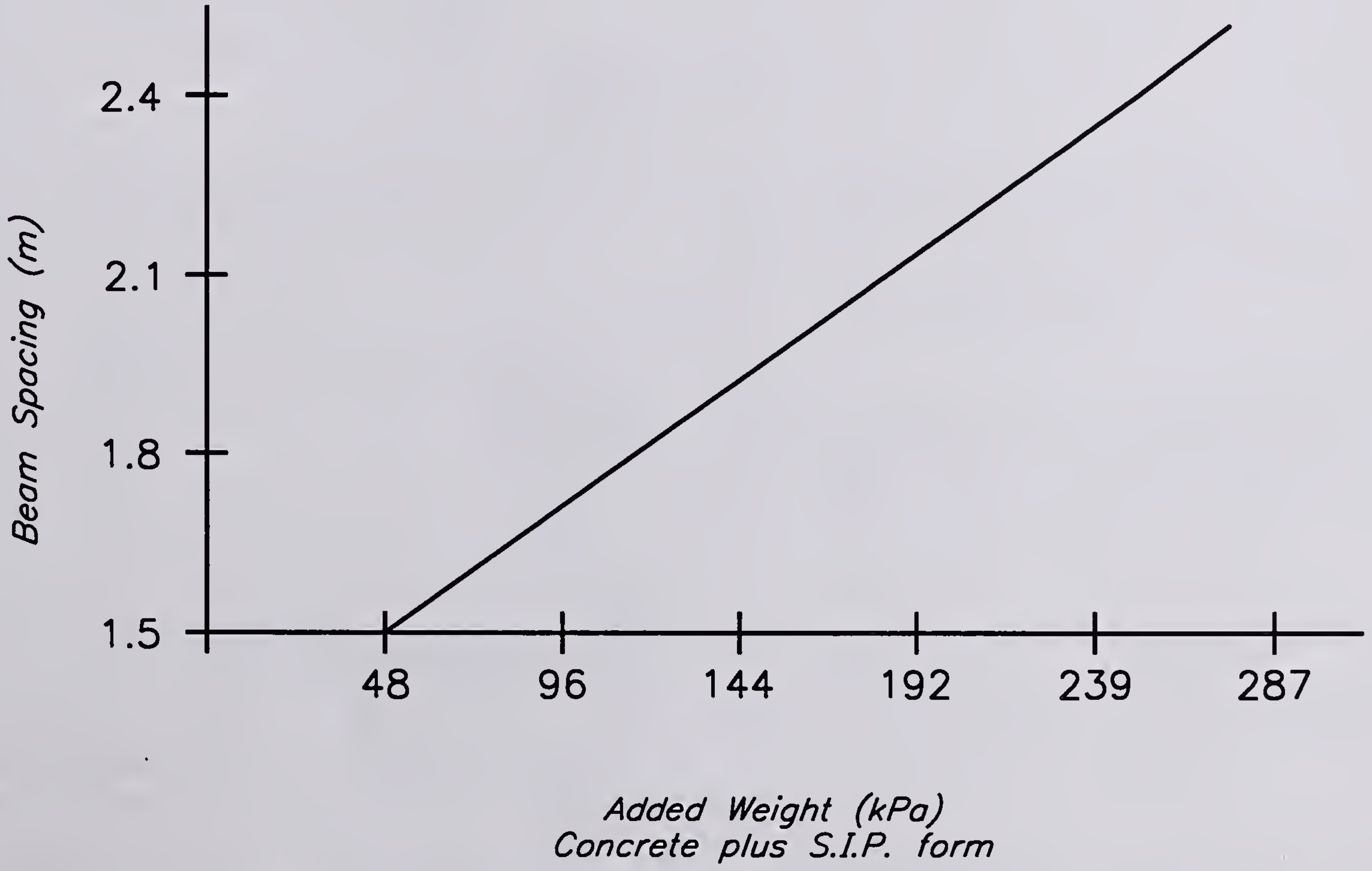
1. FOR 50 mm S.I.P. FORM, SET BOTTOM OF FORM 25 mm BELOW ELEVATION GIVEN IN TABLES. FOR 64 mm S.I.P. FORM, SET BOTTOM OF FORM 38 mm BELOW TABLE ELEVATIONS.
2. FORM ENDS SHALL BE CRIMPED CLOSED IN A TAPERED MANNER. SEPARATE END CLOSER PIECES WILL NOT BE ALLOWED.
3. SUPPORT ANGLES SHALL BE PLACED IN THE "LEG DOWN" POSITION WHERE POSSIBLE. WHERE "LEG UP" POSITION IS NECESSARY THE UPPER MOST PORTION OF THE ANGLE SHALL NOT PROJECT MORE THAN 25 mm ABOVE THE TOP FLANGE OR COVER PLATE. THE CONTRACTOR SHALL HAVE AN ASSORTMENT OF ANGLES OF VARIES SIZES AVAILABLE ON THE SITE TO CONFORM TO THIS REQUIREMENT.
4. ALL MAIN STEEL REINFORCEMENT IN THE LOWER MAT SHALL BE CENTERED OVER THE VALLEY OF THE S.I.P. FORM.
5. WHERE ALL MAIN SUPPORTING BEAMS ARE PARALLEL AND MAIN DECK STEEL IS INDICATED ON THESE PLANS AS CROSSING THE BEAM AT LESS THAN 90 DEGREES (SKEWED), THE REBAR DIRECTION MAY BE ALTERED TO CROSS THE BEAMS AT 90 DEGREES TO FACILITATE THE USE OF S.I.P. FORMS. THIS WILL BE FOR THE CONTRACTOR'S CONVENIENCE AND NO ADDITIONAL PAYMENTS WILL BE MADE FOR THIS CHANGE. REINFORCEMENT BAR SIZES AND SPACING WILL BE MAINTAINED. FOR CURVED OR NON-PARALLEL MAIN SUPPORTING BEAMS, ALTERATIONS TO DECK REINFORCING MUST BE APPROVED BY THE ENGINEER.

Plot Scale = 1:1

MASS HIGHWAY BRIDGE MANUAL	CONSTRUCTION NOTES STAY-IN-PLACE FORMS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **7.2.2**

NOTES:

1. *If all corrugations are filled with concrete to the top of the S.I.P. form, it is approximately equivalent to a 25 mm thick layer of concrete over the entire form. Therefore, for approximate equivalent concrete deck weights between removeable and S.I.P. forms:*
   - *A. Set the bottom of S.I.P. form 25 mm below the top of form elevation for 50 mm deep forms.*
   - *B. Set the bottom of S.I.P. form 38 mm below the top of form elevation for 64 mm deep forms.*
   - *C. Main steel reinforcement shall be centered over the trough of the S.I.P. form.*
2. *S.I.P. forms are required by the department for deck construction over rivers, active railroad tracks and roadways which will remain open to the public during construction. In all other installations the contractor is given the option to use S.I.P. forms or removeable forms. Details and notes for S.I.P. forms shall be shown on the construction plans for all deck construction projects.*
3. *When designing supporting beams, see the chart below for the additional weight to be included in the design to account for any additional concrete and the weight of the S.I.P. forms.*



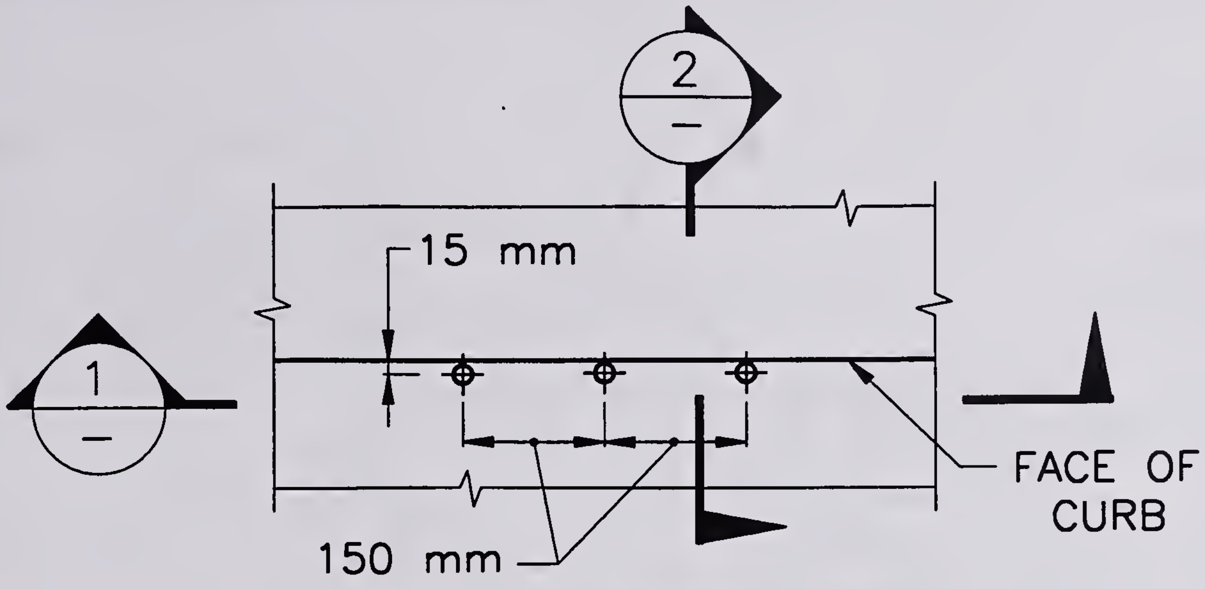
Plot Scale = 1:1

MASSHIGHWAY
BRIDGE
MANUAL

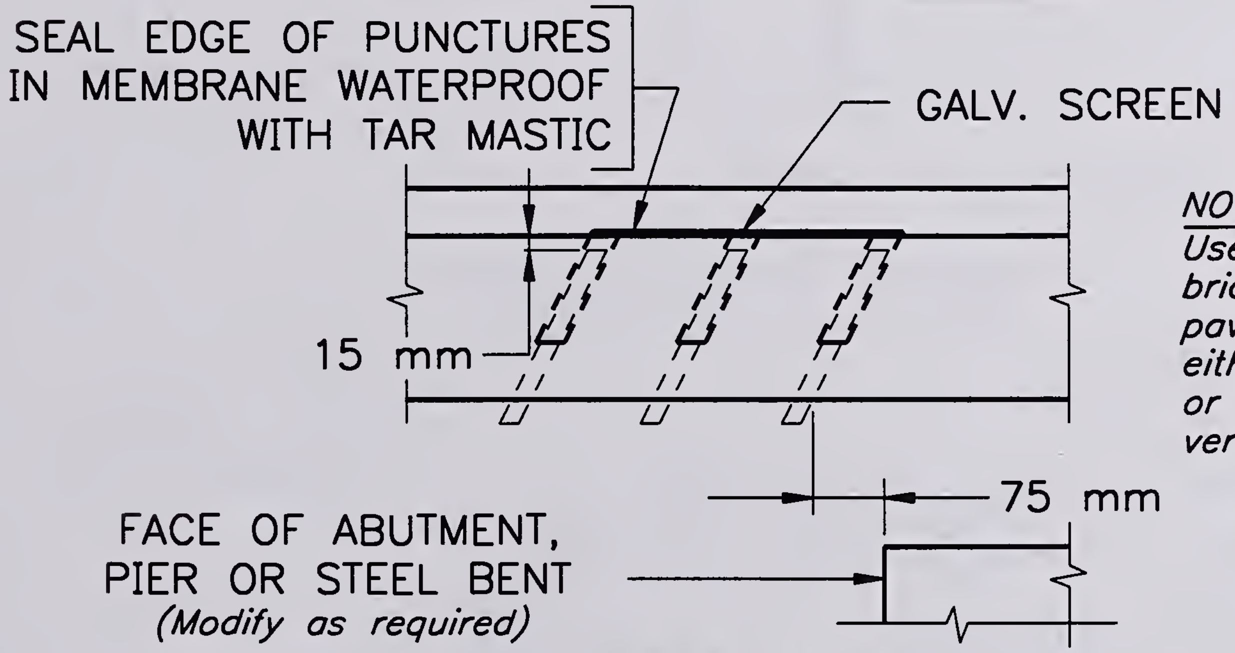
DESIGNER NOTES
STAY–IN–PLACE FORMS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.2.3

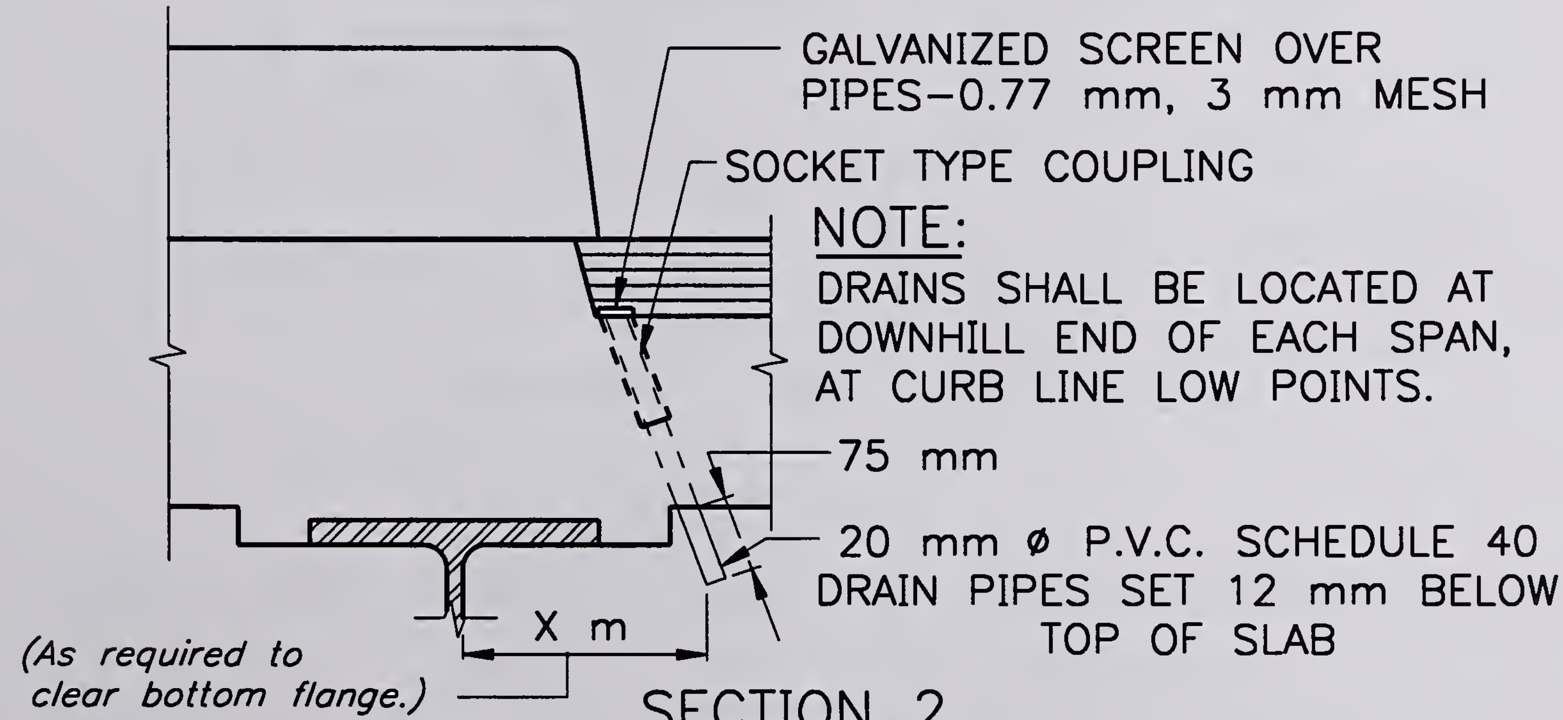


DECK PLAN AT DRAIN PIPE


SEAL EDGE OF PUNCTURES IN MEMBRANE WATERPROOF WITH TAR MASTIC
GALV. SCREEN
15 mm
75 mm
FACE OF ABUTMENT, PIER OR STEEL BENT
(Modify as required)

NOTE:
Use deck drains for bridges with bit. conc. pavement only and at either armored joints or low point of vertical curve.

SECTION 1


GALVANIZED SCREEN OVER PIPES–0.77 mm, 3 mm MESH
SOCKET TYPE COUPLING
75 mm
20 mm ø P.V.C. SCHEDULE 40 DRAIN PIPES SET 12 mm BELOW TOP OF SLAB
X m
(As required to clear bottom flange.)

NOTE:
DRAINS SHALL BE LOCATED AT DOWNHILL END OF EACH SPAN, AT CURB LINE LOW POINTS.

SECTION 2

DETAIL OF DRAIN PIPES THROUGH DECK SLAB

SCALE 1:10

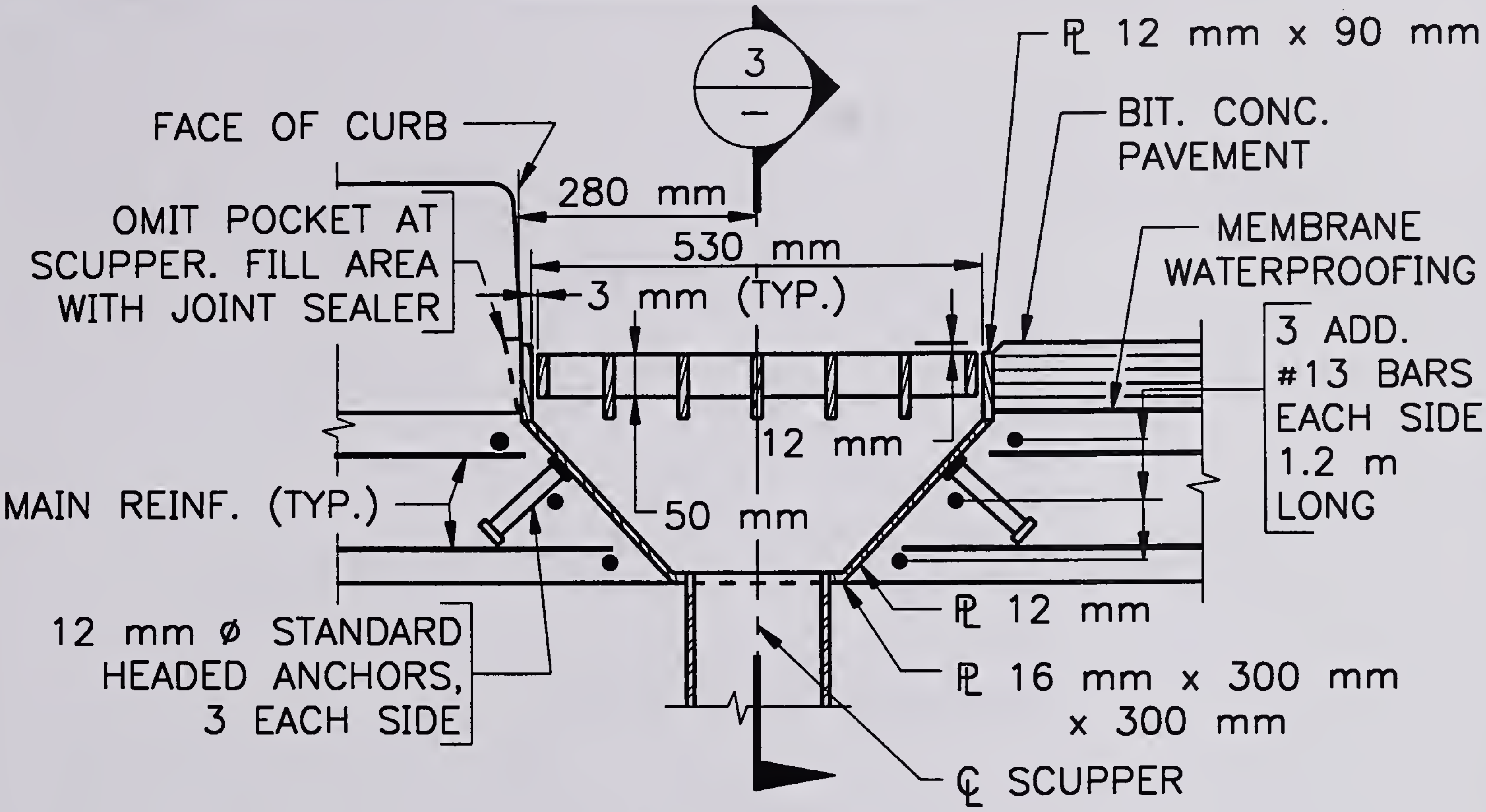
Plot Scale = 1:10

MASS HIGHWAY
BRIDGE
MANUAL

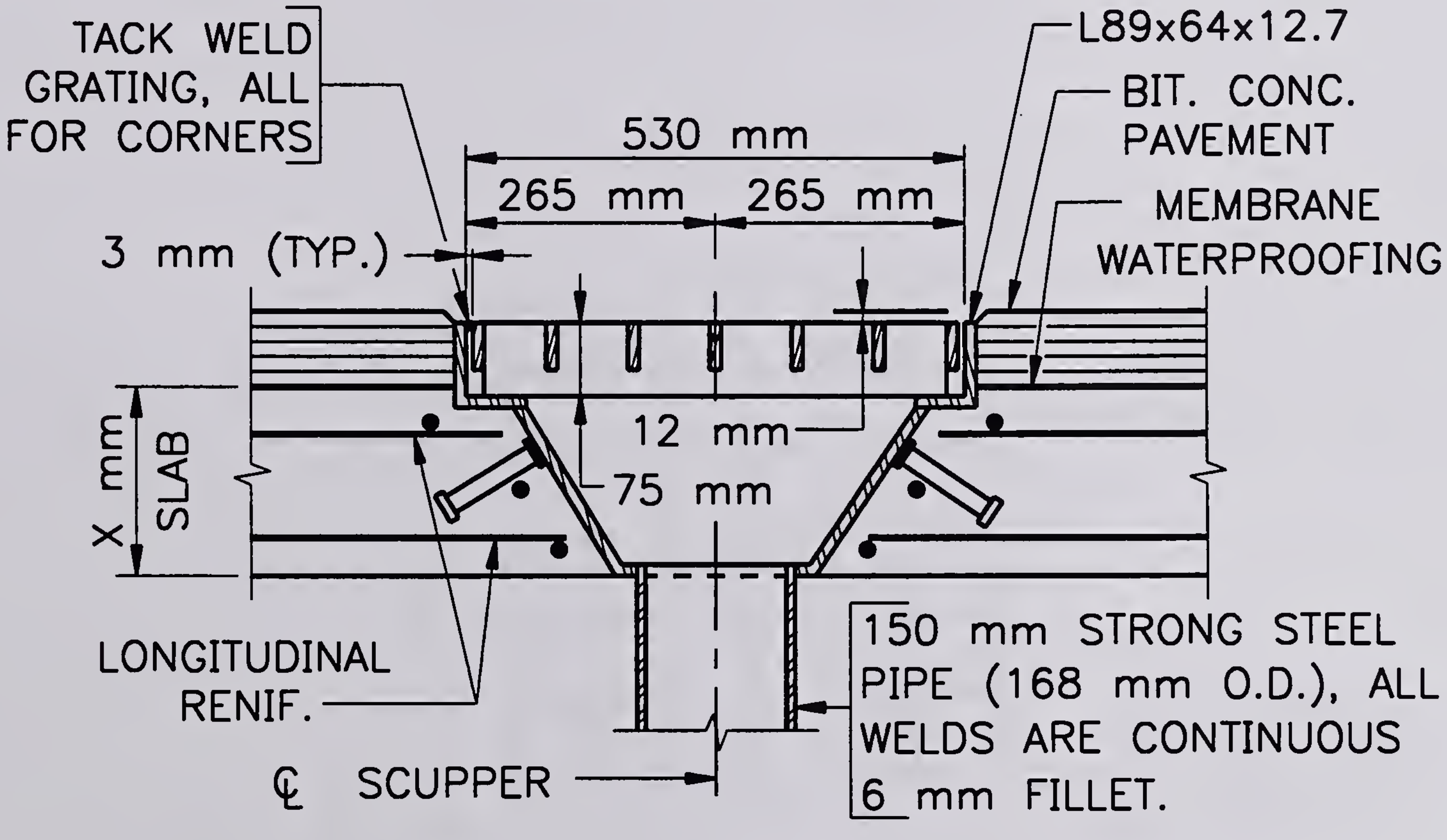
DECK DRAIN PIPES
DRAINAGE DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.3.1


3
—
℄ 12 mm x 90 mm
FACE OF CURB
BIT. CONC. PAVEMENT
280 mm
OMIT POCKET AT SCUPPER. FILL AREA WITH JOINT SEALER
530 mm
MEMBRANE WATERPROOFING
3 mm (TYP.)
3 ADD. #13 BARS EACH SIDE 1.2 m LONG
12 mm
MAIN REINF. (TYP.)
50 mm
℄ 12 mm
12 mm ø STANDARD HEADED ANCHORS, 3 EACH SIDE
℄ 16 mm x 300 mm x 300 mm
℄ SCUPPER

SECTION AT CURB



SECTION 3

NOTE: DOWN SPOUT FITTINGS TO HAVE MECHANICAL JOINTS.

SCUPPER–SECTION VIEWS

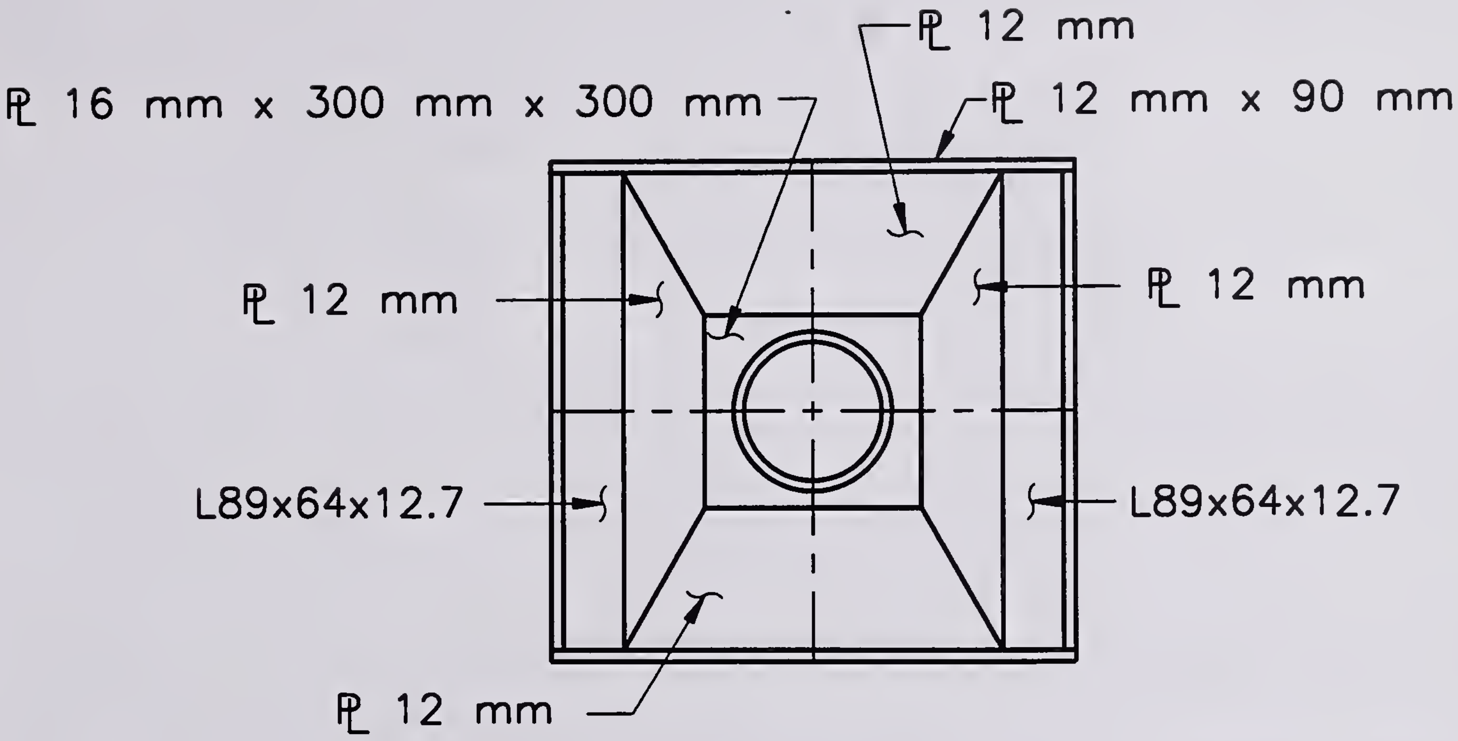
SCALE 1:10

NOTES:

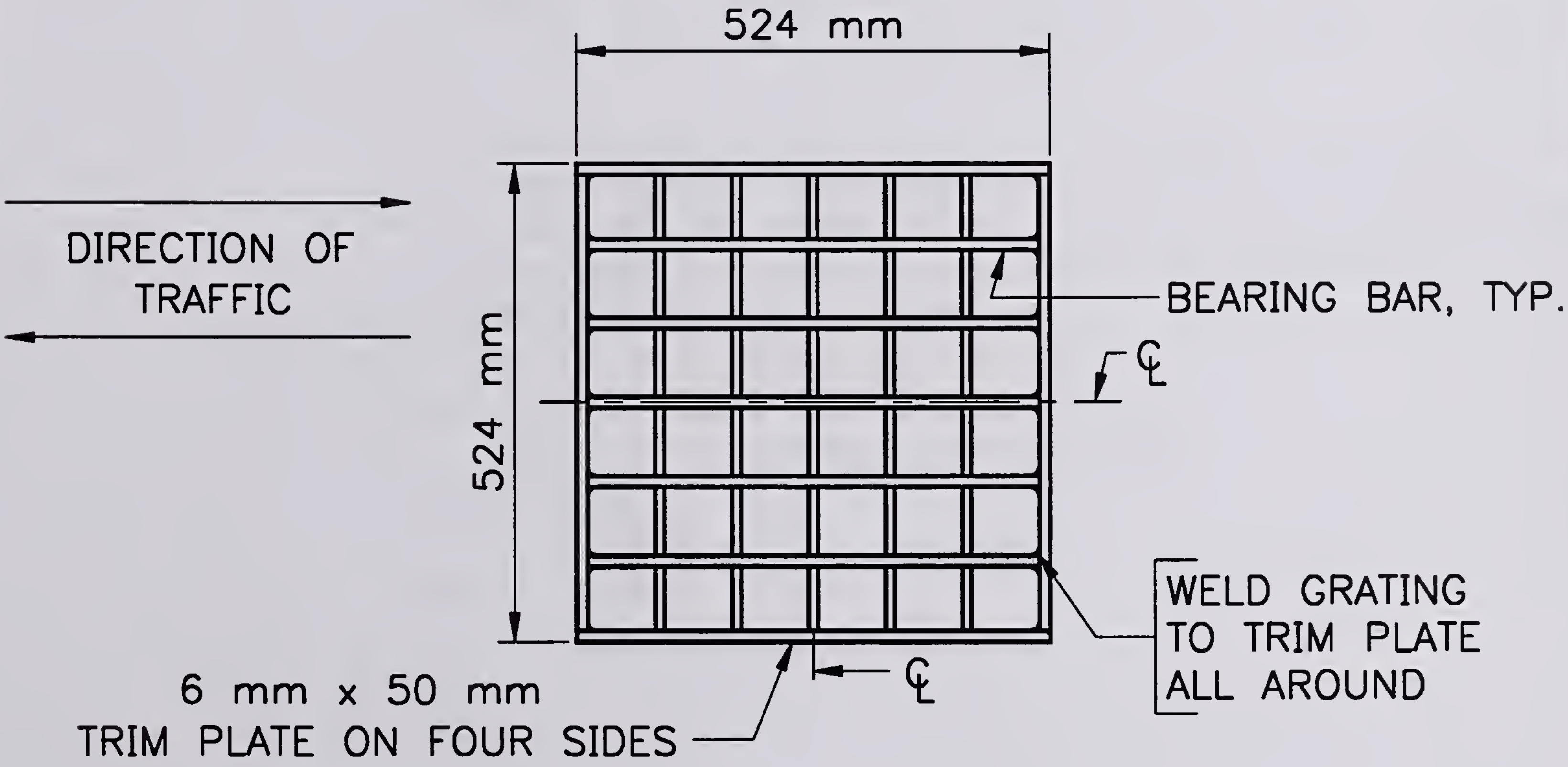
1. *For scupper at median, place scupper against bent plate and weld.*
2. *Details of scupper to be adjusted where beam interferes with location.*

Plot Scale = 1:10

MASSHIGHWAY BRIDGE MANUAL	SCUPPERS–SECTION VIEWS DRAINAGE DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **7.3.2**



PLAN
(GRATING REMOVED)


524 mm
524 mm
DIRECTION OF TRAFFIC
BEARING BAR, TYP.
℄
WELD GRATING TO TRIM PLATE ALL AROUND
6 mm x 50 mm TRIM PLATE ON FOUR SIDES
℄

PLAN OF GRATING

SCUPPER–PLAN VIEWS

SCALE 1:10

Plot Scale = 1:10

MASS HIGHWAY
BRIDGE MANUAL

SCUPPER–PLAN VIEWS
DRAINAGE DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
7.3.3

NOTES:

1. Railings and barriers referenced in the bridge manual by their performance level shall be referenced on the plans thus:

MANUAL NAME	ON PLANS
CT-PL1* BARRIER	TEXAS RAIL
S3-PL2 RAIL	S3-PL2 RAIL
CP-PL2 BARRIER	PARAPET WALL
CF-PL2 BARRIER	CF-PL2 BARRIER
CF-PL3 BARRIER	CF-PL3 BARRIER

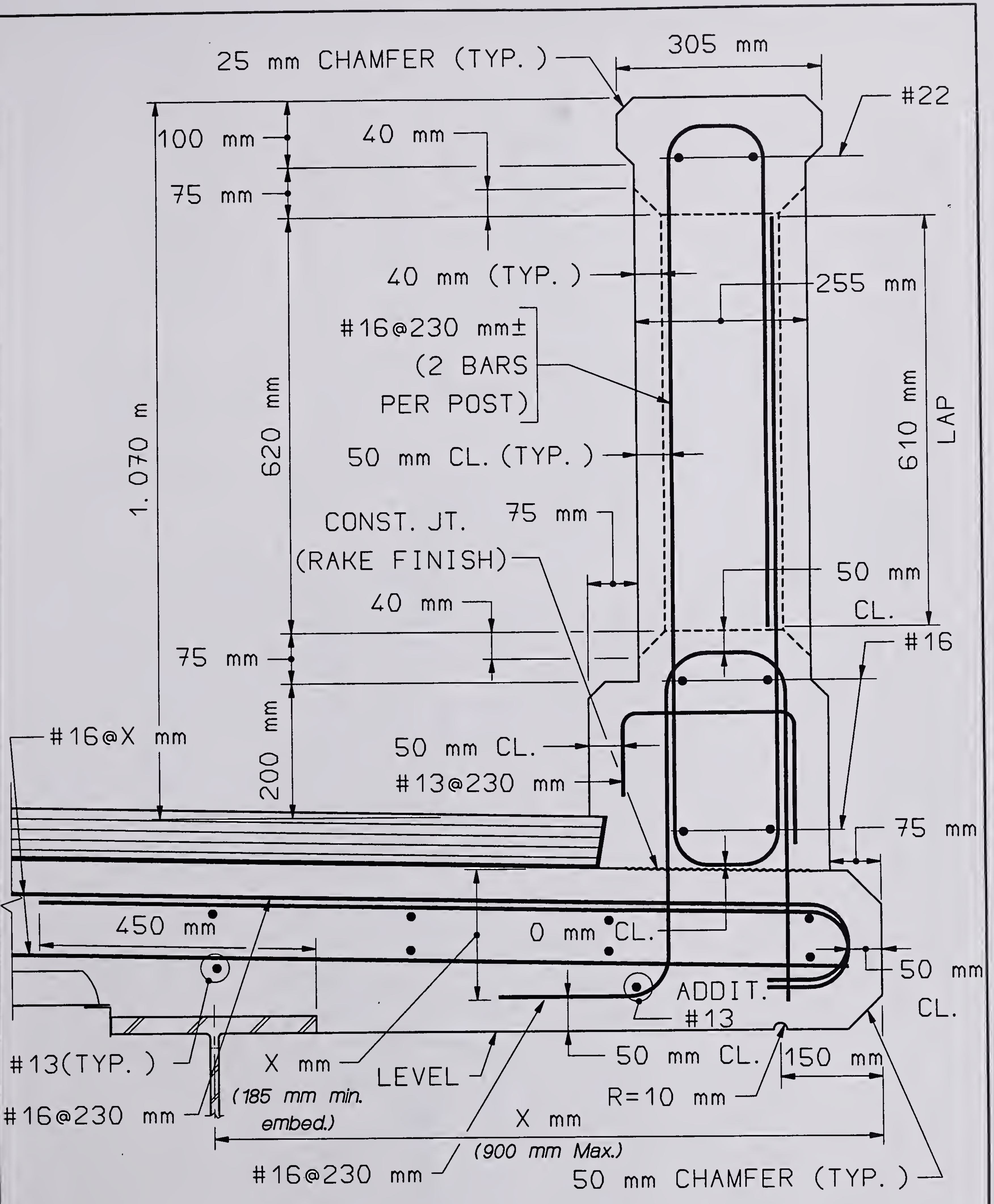
2. All concrete for railing/traffic barrier systems shall be 35 MPa, 20 mm, 385 kg silica fume modified cement concrete masonry, except for the CT-PL1* Rail which shall be 35 MPa 10 mm, 385 kg silica fume modified cement concrete masonry, and shall be noted on the construction plans. Concrete penetrant is not required for railings and barriers composed of silica fume modified cement concrete masonry.
3. Details of railings for separated precast concrete beam bridges are similar to the details for the steel beam bridges except that the maximum overhang shall be 760 mm from the outside edge of precast beam.
4. The details of the dowel arrangement for the attachment of the sidewalk slab to the precast butted beam bridge are shown in Chapter 4, Section 3.
5. The minimum depth of slab for the overhanging sidewalk is 275 mm for the Texas Rail and the Parapet Wall (See Dwg. No's. 9.2.4 and 9.4.4) and is 280 mm for the S3-PL2 Rail (See Dwg. No. 9.3.3). All overhanging sidewalks are designed for utility loads up to 373 kg/m and are centered in the overhang. The minimum depth of slab for the roadway deck (outside the exterior beam) is 235 mm at the location of the embedded reinforcement.
6. If the decks are less than the stated minimum thicknesses or exceed the maximum overhang, the designer is responsible for determining the appropriate reinforcement in the deck and sidewalk slabs and the embedment of the barrier and rail attachments.
7. The unit weights of the unmodified concrete rails and barriers are as follows:
   - CT-PL1* at sidewalk: 515 kg/m (between pilasters).
   - CT-PL1* pilaster (410 mm long) at sidewalk: 280 kg/EA.
   - CT-PL1* at safety curb: 640 kg/m
   - CT-PL1* pilaster (410 mm long) at safety curb: 330 kg/EA.
   - S3-PL2 at sidewalk: 134 kg/m
   - S3-PL2 at safety curb: 128 kg/m
   - CP-PL2 at sidewalk: 610 kg/m
   - CP-PL2 at safety curb: 720 kg/m
   - CF-PL2: 710 kg/m
   - CF-PL3: 995 kg/m

MASS HIGHWAY
BRIDGE
MANUAL

DESIGNER NOTES
GENERAL

DATE OF ISSUE
DECEMBER, 1995

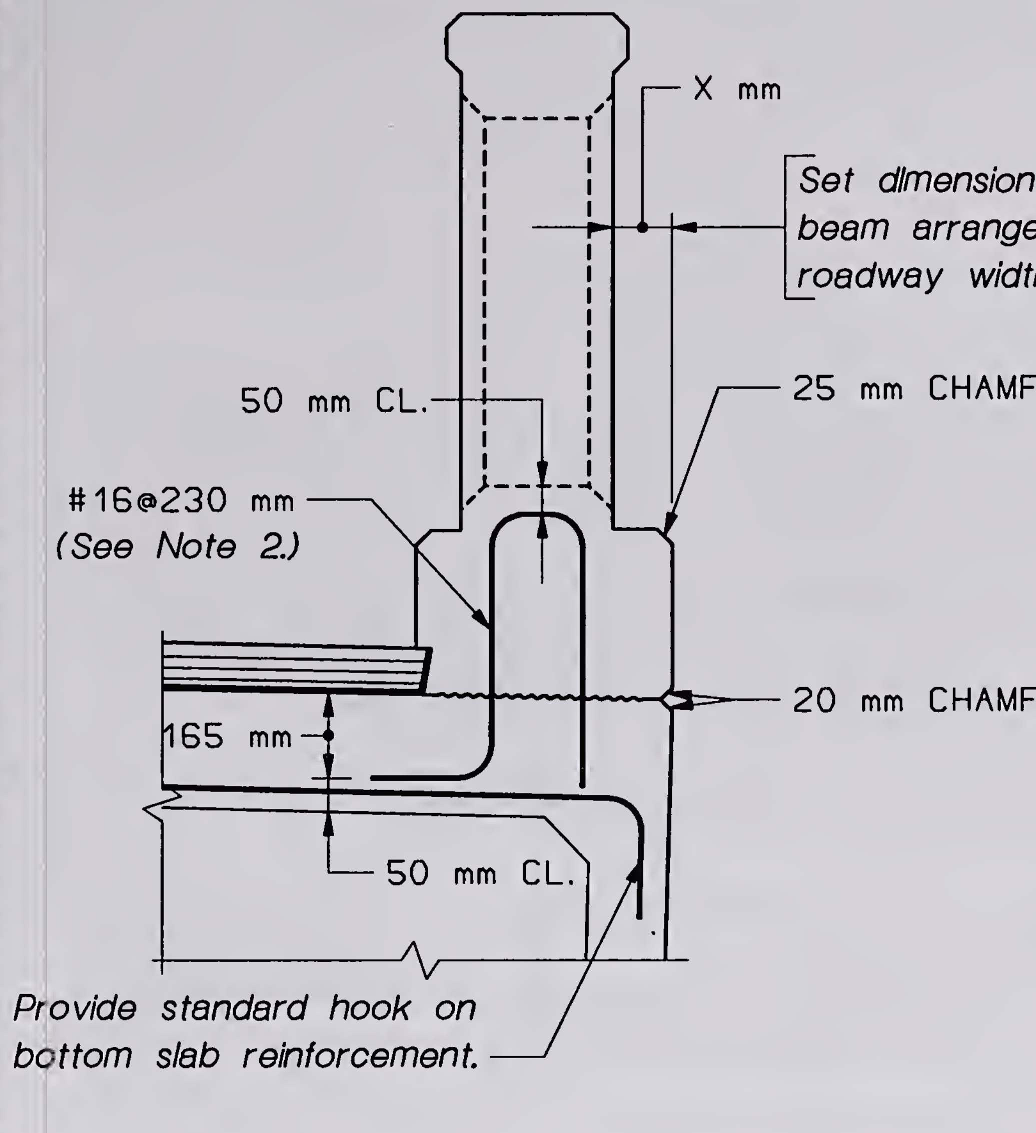
DRAWING NUMBER
9.1.1



SECTION THRU TEXAS RAIL AT SAFETY CURB

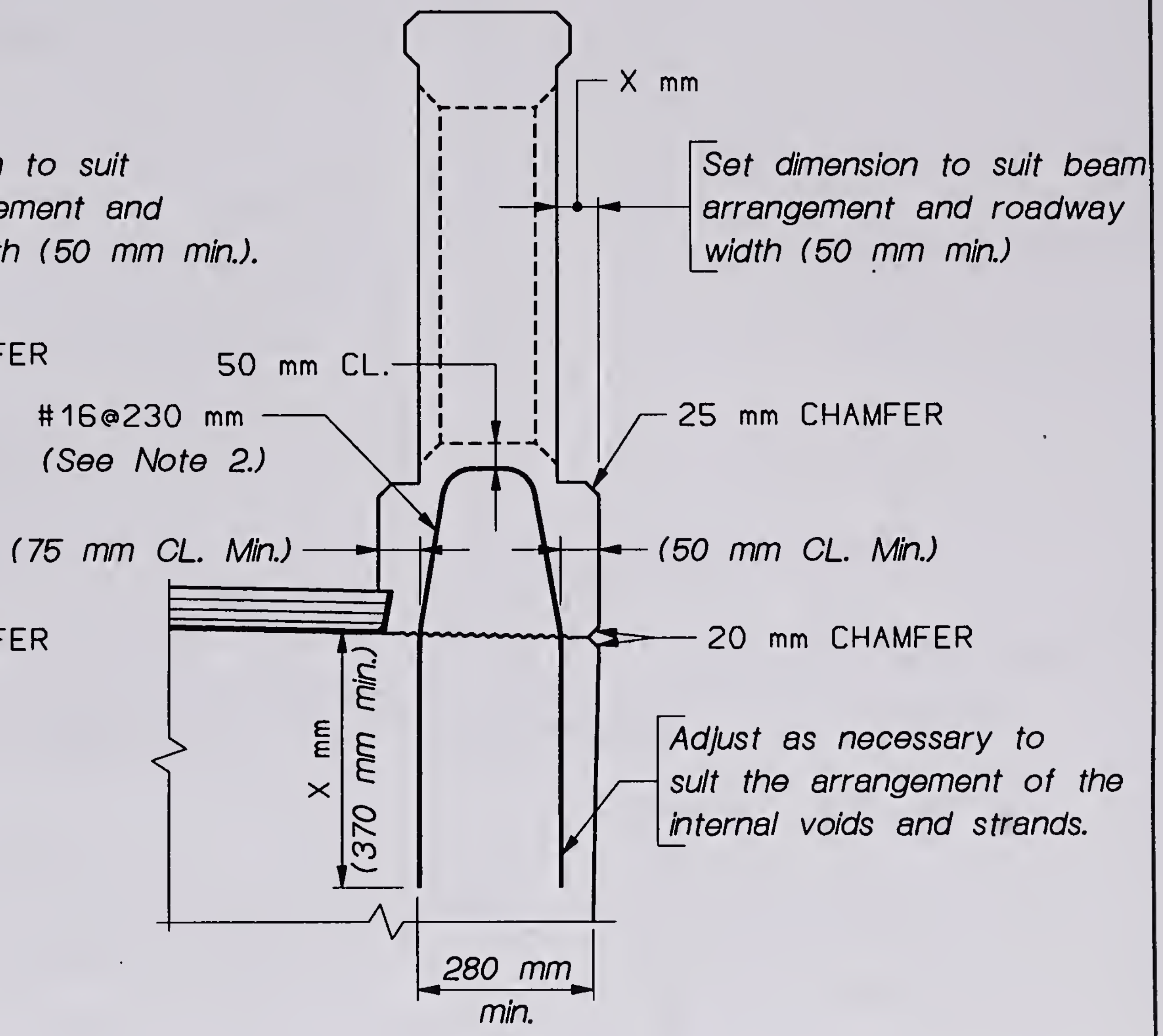
Draw to 1:10 scale min.

MASS HIGHWAY BRIDGE MANUAL	DETAILS AT SAFETY CURB CT-PL1* RAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.2.1**


X mm
Set dimension to suit beam arrangement and roadway width (50 mm min.).
50 mm CL.
25 mm CHAMFER
#16@230 mm
(See Note 2.)
20 mm CHAMFER
165 mm
50 mm CL.
Provide standard hook on bottom slab reinforcement.

SECTION THRU RAIL

(SI & BI MOD. - BIV MOD. BEAMS)


X mm
Set dimension to suit beam arrangement and roadway width (50 mm min.)
50 mm CL.
#16@230 mm
(See Note 2.)
25 mm CHAMFER
(75 mm CL. Min.)
(50 mm CL. Min.)
20 mm CHAMFER
X mm
(370 mm min.)
Adjust as necessary to suit the arrangement of the internal voids and strands.
280 mm
min.

SECTION THRU RAIL

(SII - SIV BEAMS)

NOTES:

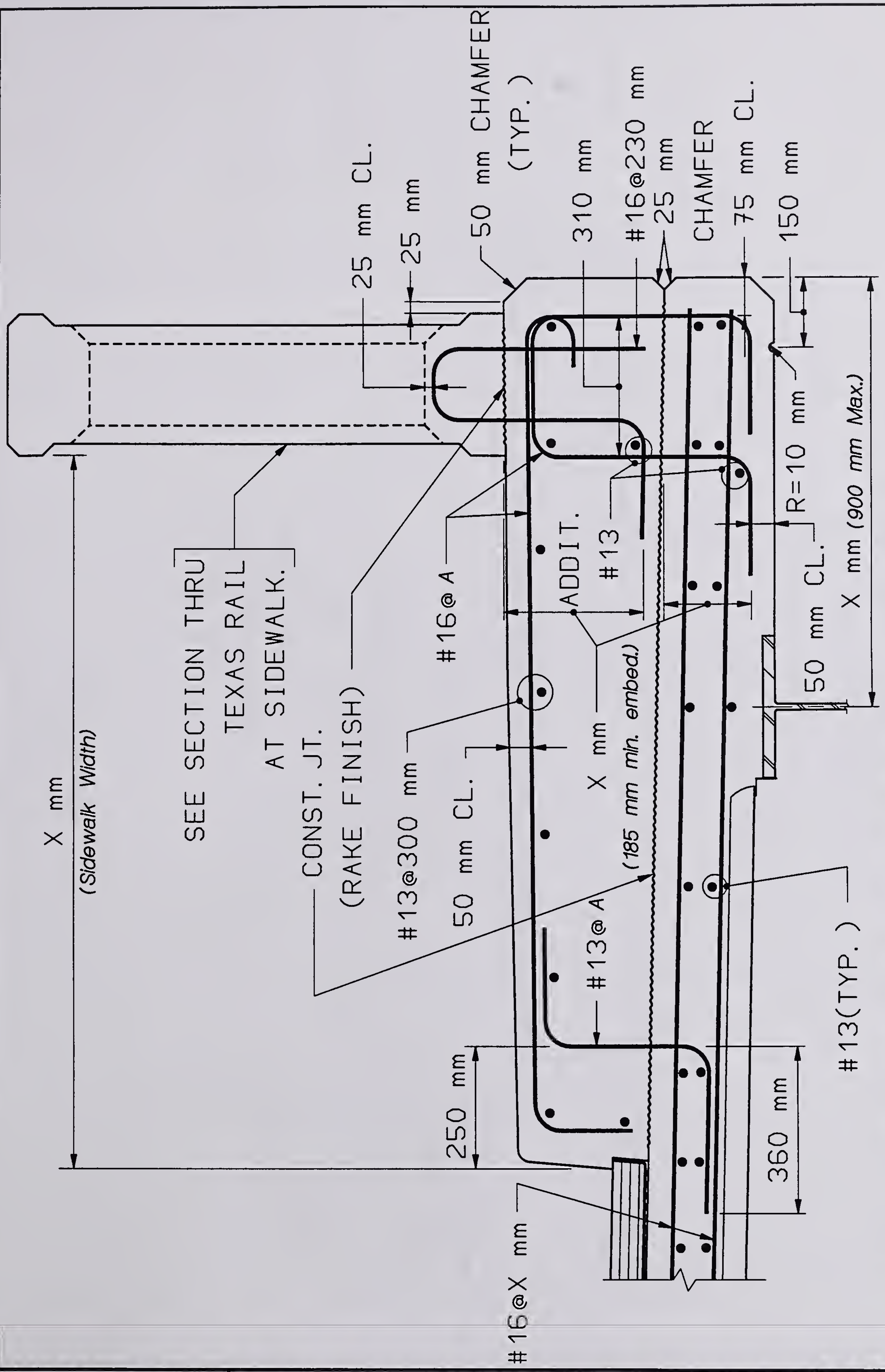
1. Modify the width ("X") and reinforcement of the "Section Thru Texas Rail at Safety Curb" (Dwg. No. 9.2.1), to the extent shown above, to suit the arrangement of the butted beams, the internal voids, and the strands.
2. Bars extending from the top of the beams shall be spaced at multipes of beam reinforcement and shall provide no less than #16@230 mm reinforcement.

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR PRECAST
BUTTED BEAM BRIDGES
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.2



NOTE: A - Same spacing as deck slab reinforcement (215 mm max. spacing).

SECTION THRU SIDEWALK

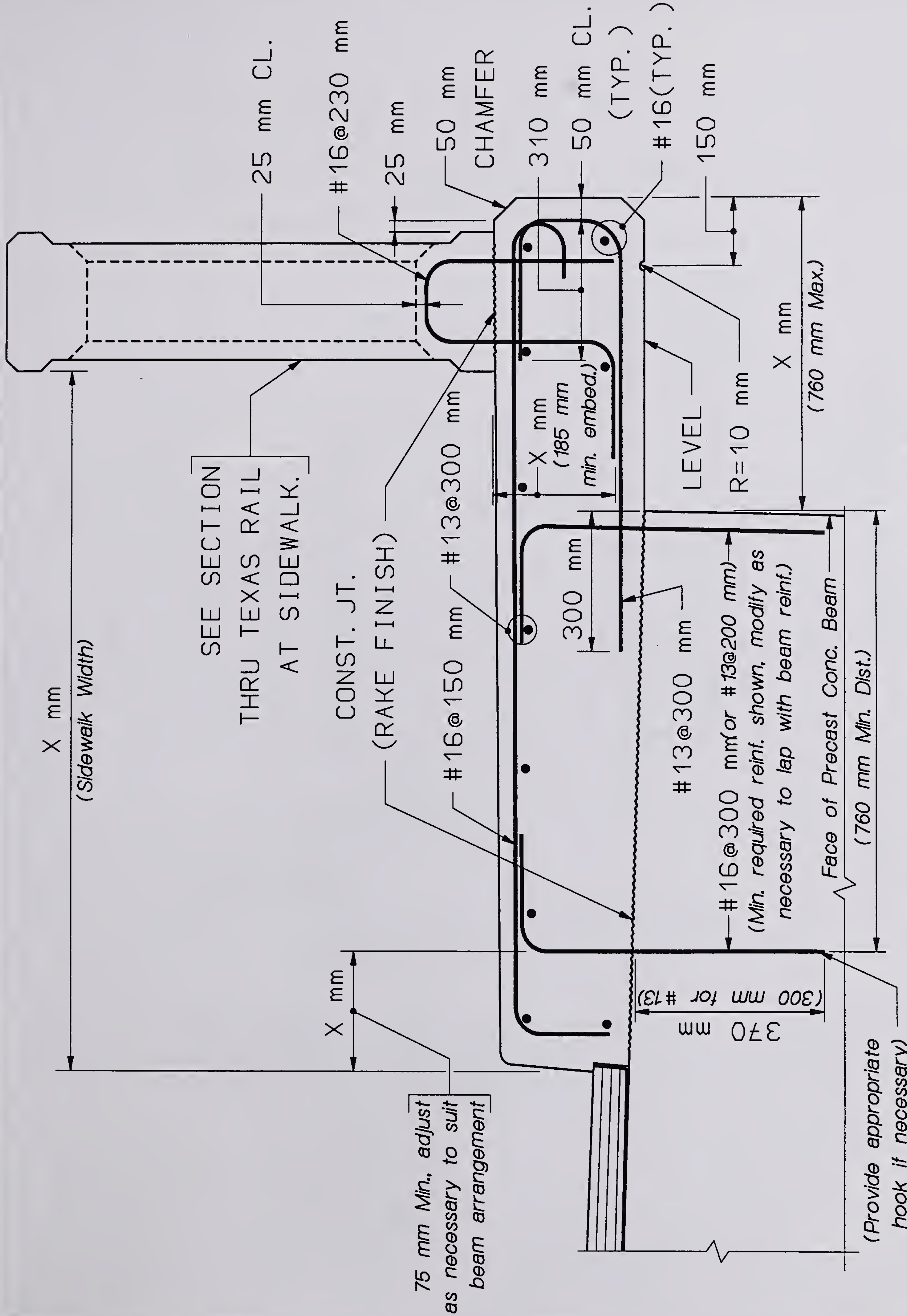
Draw to 1:10 scale min.

MASS HIGHWAY
BRIDGE
MANUAL

SECTION THRU SIDEWALK
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.3


25 mm CL.
#16@230 mm
25 mm
50 mm CHAMFER
310 mm
50 mm CL. (TYP.)
#16(TYP.)
150 mm
X mm (760 mm Max.)
SEE SECTION THRU TEXAS RAIL AT SIDEWALK.
CONST. JT. (RAKE FINISH)
#13@300 mm
X mm (185 mm min. embed.)
LEVEL
R=10 mm
X mm (Sidewalk Width)
300 mm
#16@150 mm
#13@300 mm
#16@300 mm(or #13@200 mm) (Min. required reinf. shown, modify as necessary to lap with beam reinf.)
Face of Precast Conc. Beam
(760 mm Min. Dist.)
X mm
75 mm Min., adjust as necessary to suit beam arrangement
370 mm (300 mm for #13)
(Provide appropriate hook if necessary)

SECTION THRU SIDEWALK

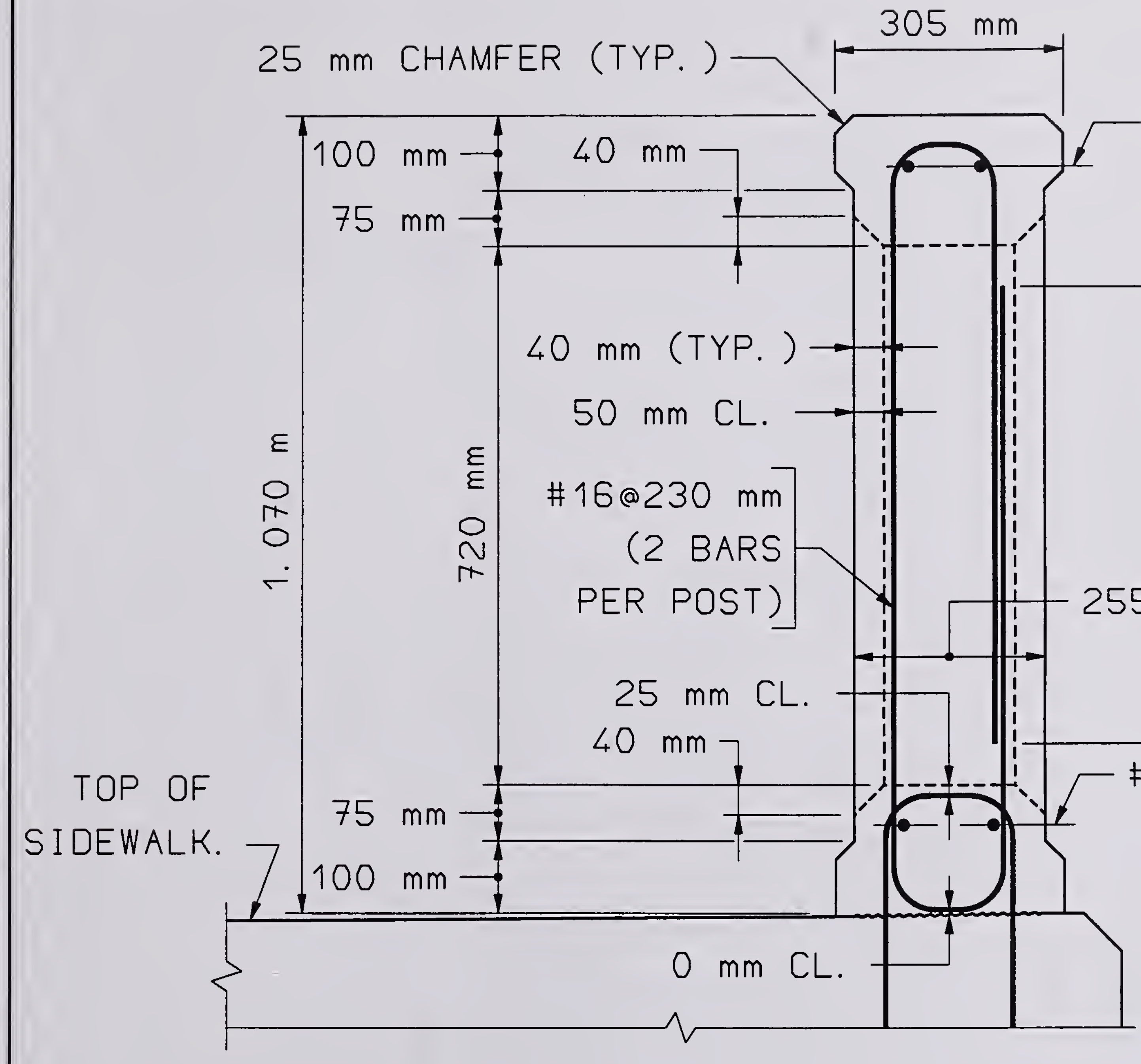
Draw to 1:10 scale min.

MASS HIGHWAY
BRIDGE MANUAL

SECTION THRU
OVERHANGING SIDEWALK
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.4



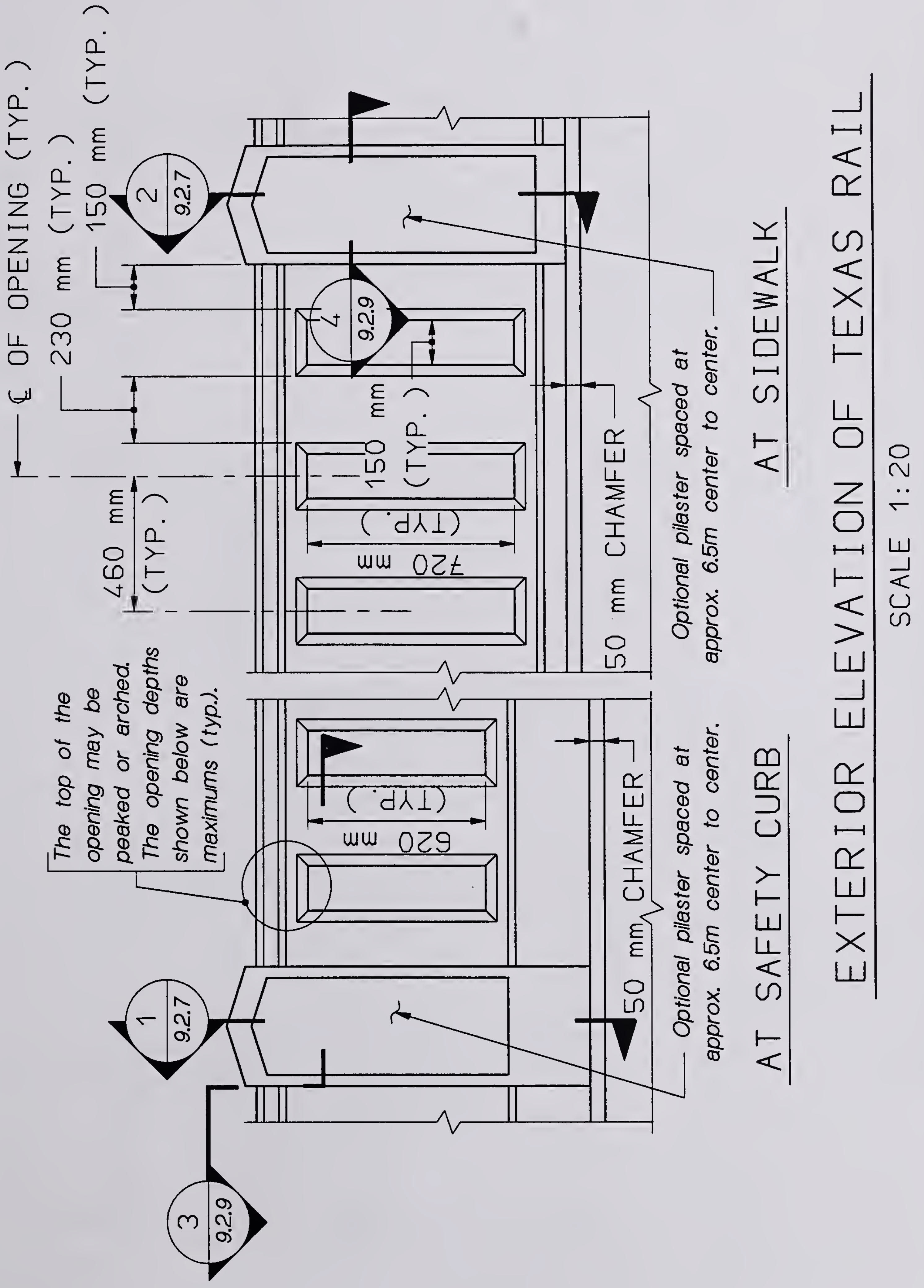
NOTE:

FOR SIDEWALK REINFORCEMENT, SEE SECTION THRU SIDEWALK.

SECTION THRU TEXAS RAIL AT SIDEWALK

SCALE 1:10

MASS HIGHWAY BRIDGE MANUAL	DETAILS AT SIDEWALK CT-PL1* RAIL	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER 9.2.5



The top of the opening may be peaked or arched. The opening depths shown below are maximums (typ.).

Optional pilaster spaced at approx. 6.5m center to center.

Optional pilaster spaced at approx. 6.5m center to center.

AT SAFETY CURB

AT SIDEWALK

EXTERIOR ELEVATION OF TEXAS RAIL

SCALE 1:20

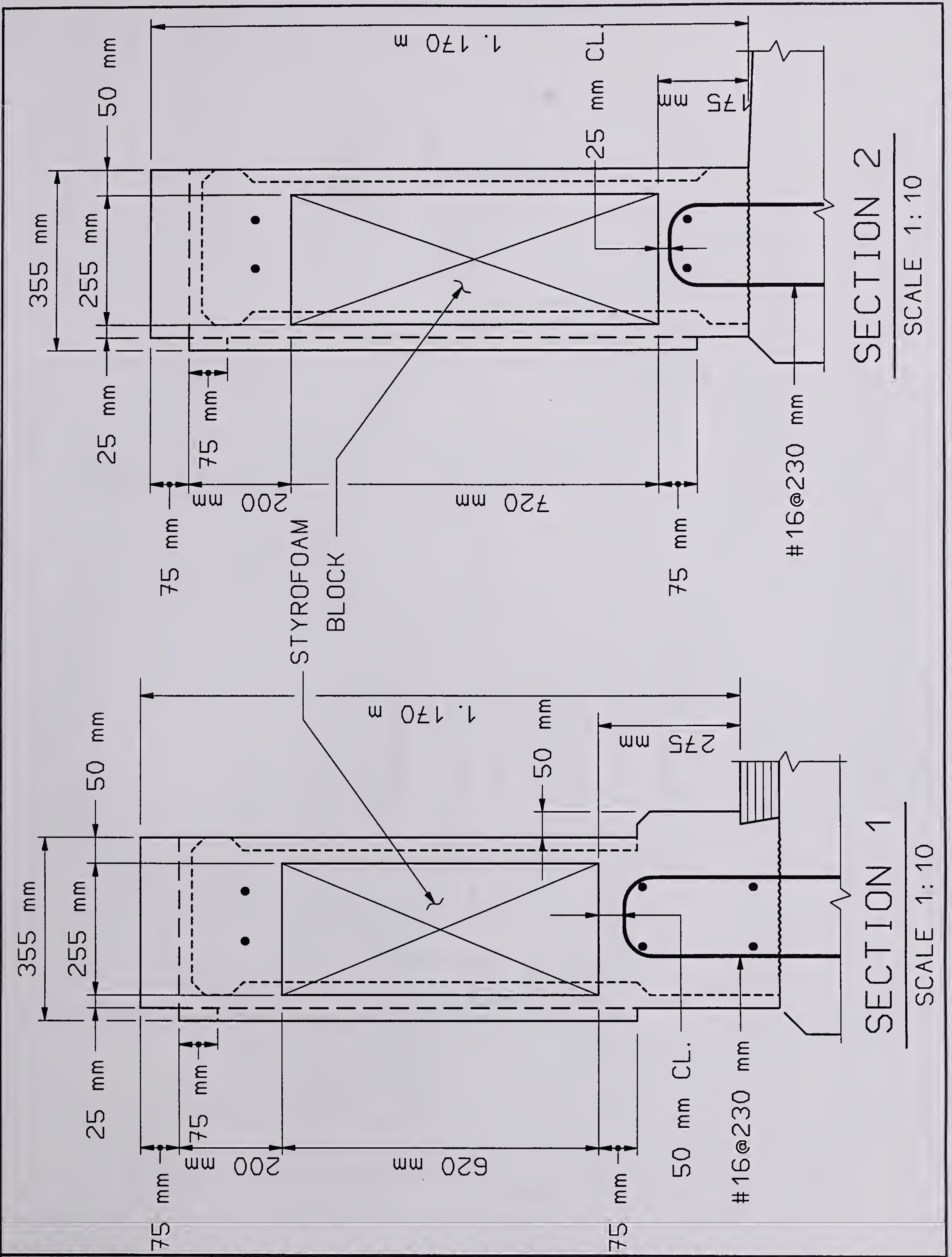
MASS HIGHWAY
BRIDGE
MANUAL

ELEVATION OF RAIL

CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.6

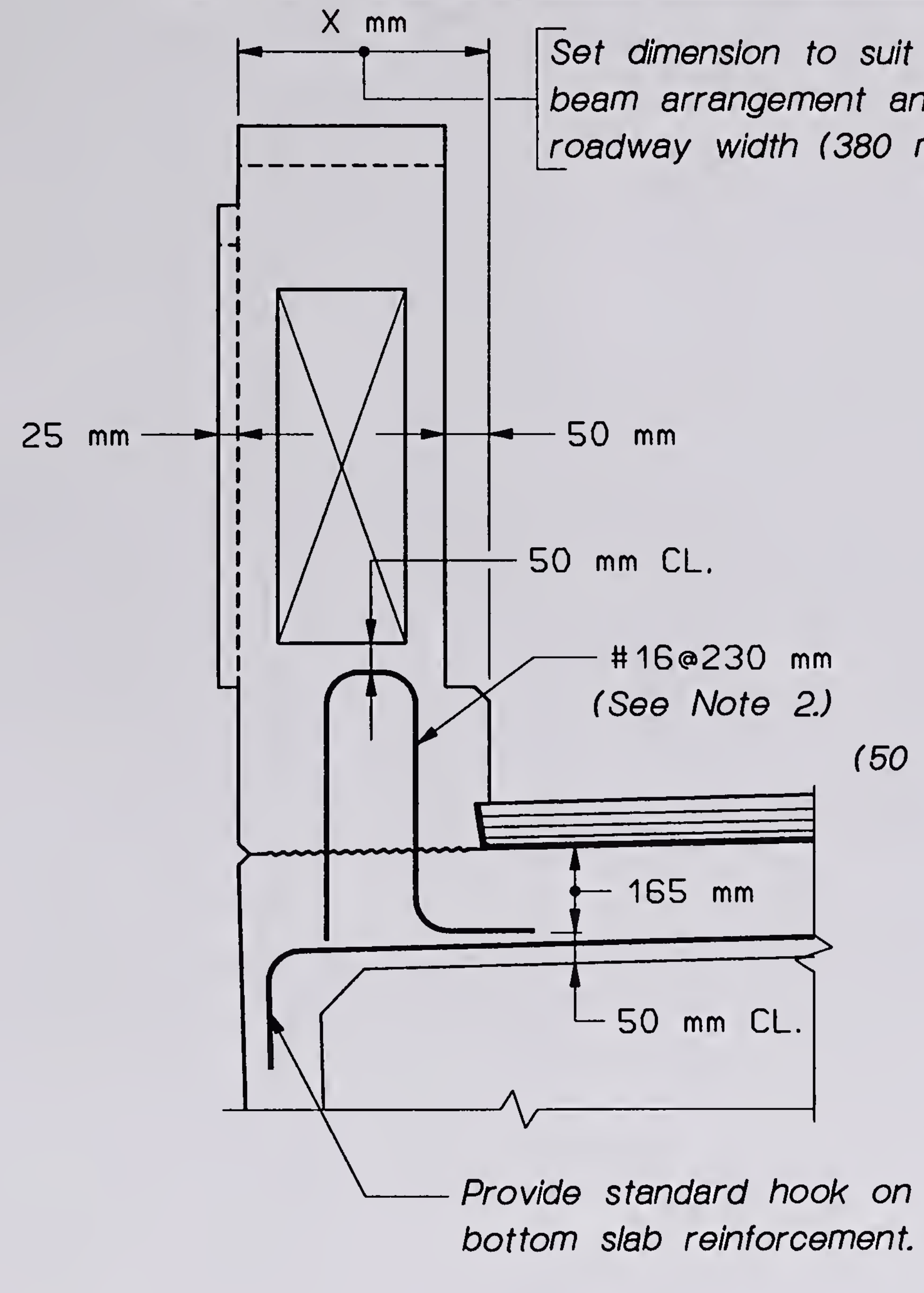


MASS HIGHWAY
BRIDGE MANUAL

VERT. SECTIONS OF OPTIONAL PILASTERS
CT-PL1* RAIL

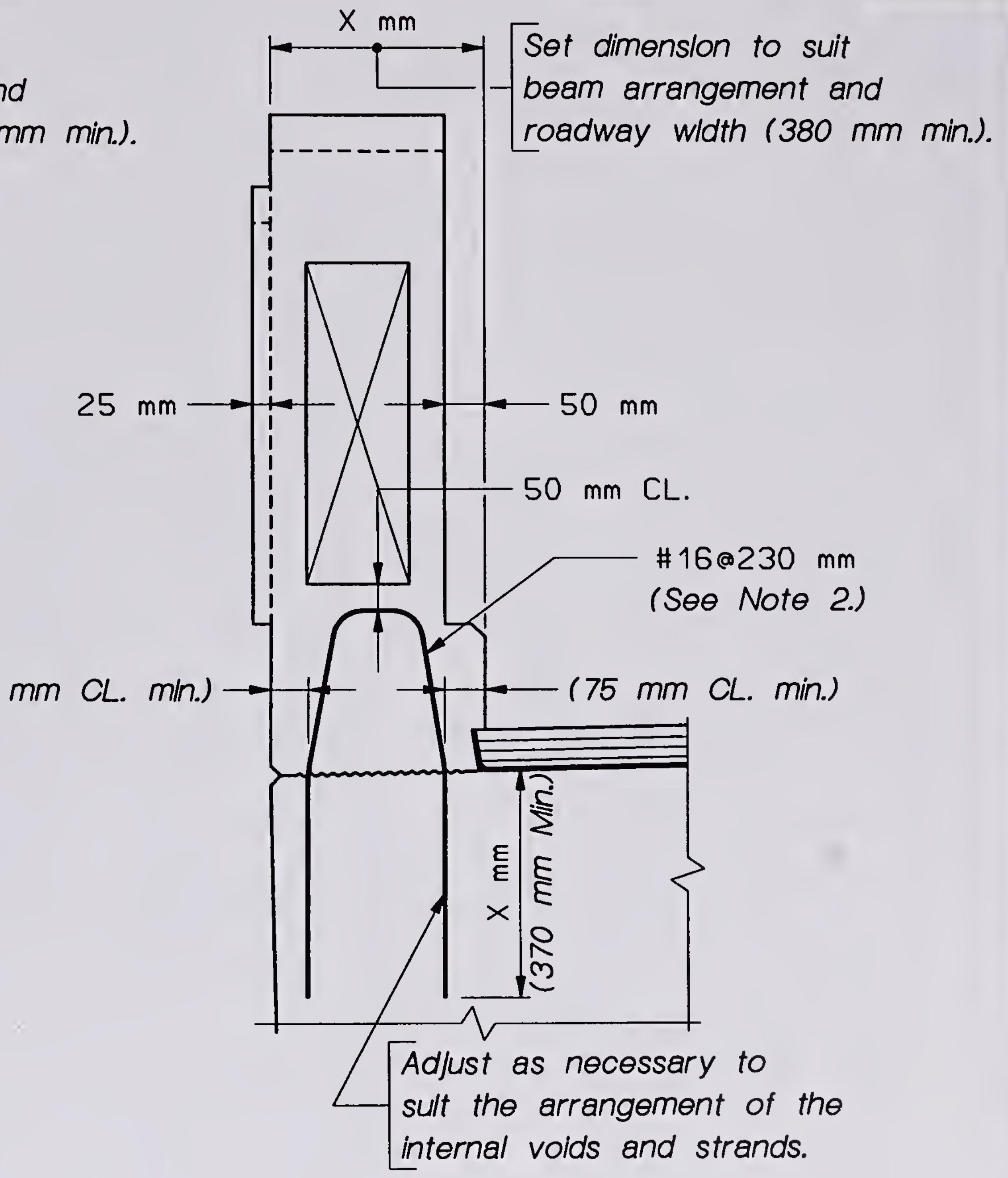
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.7


X mm
Set dimension to suit beam arrangement and roadway width (380 mm min.).
25 mm
50 mm
50 mm CL.
#16@230 mm (See Note 2.)
165 mm
50 mm CL.
Provide standard hook on bottom slab reinforcement.

SECTION THRU PILASTER

(SI & BI MOD. - BIV MOD. BEAMS)


X mm
Set dimension to suit beam arrangement and roadway width (380 mm min.).
25 mm
50 mm
50 mm CL.
#16@230 mm (See Note 2.)
(50 mm CL. min.)
(75 mm CL. min.)
X mm
(370 mm Min.)
Adjust as necessary to suit the arrangement of the internal voids and strands.

SECTION THRU PILASTER

(SII - SIV BEAMS)

NOTES:

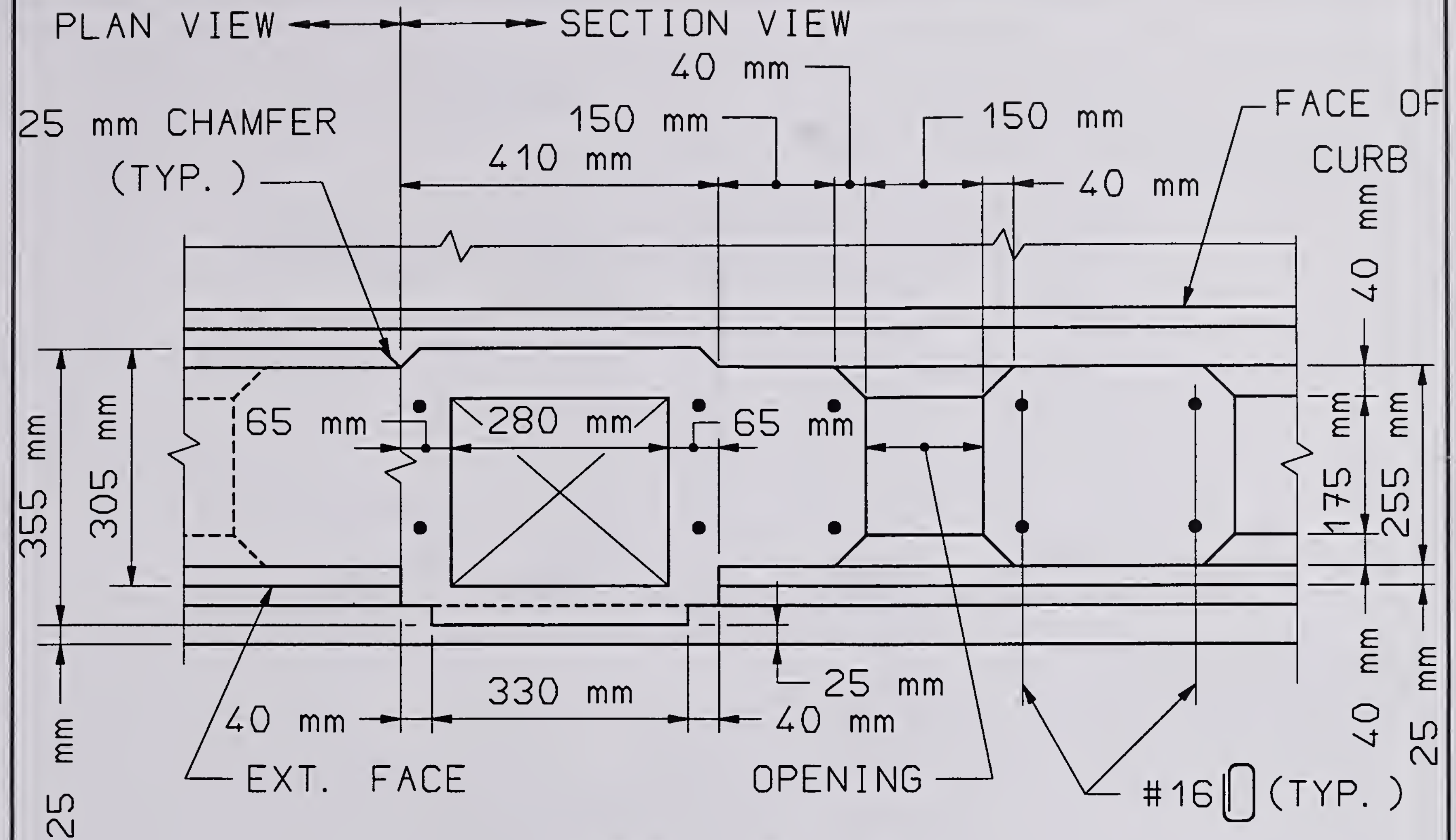
1. Modify the width and reinforcement of the vertical section thru pilaster at safety curb (Dwg. No. 9.2.7), to the extent shown above, to suit the arrangement of the butted beams, the internal voids, and the strands.
2. Bars extending from the top of the beams shall be spaced at multipes of beam reinforcement and shall provide no less than #16@230 mm reinforcement.

MASS HIGHWAY
BRIDGE
MANUAL

PILASTER MODIFICATIONS FOR
PRECAST BUTTED BM. BRIDGES
CT-PL1* RAIL

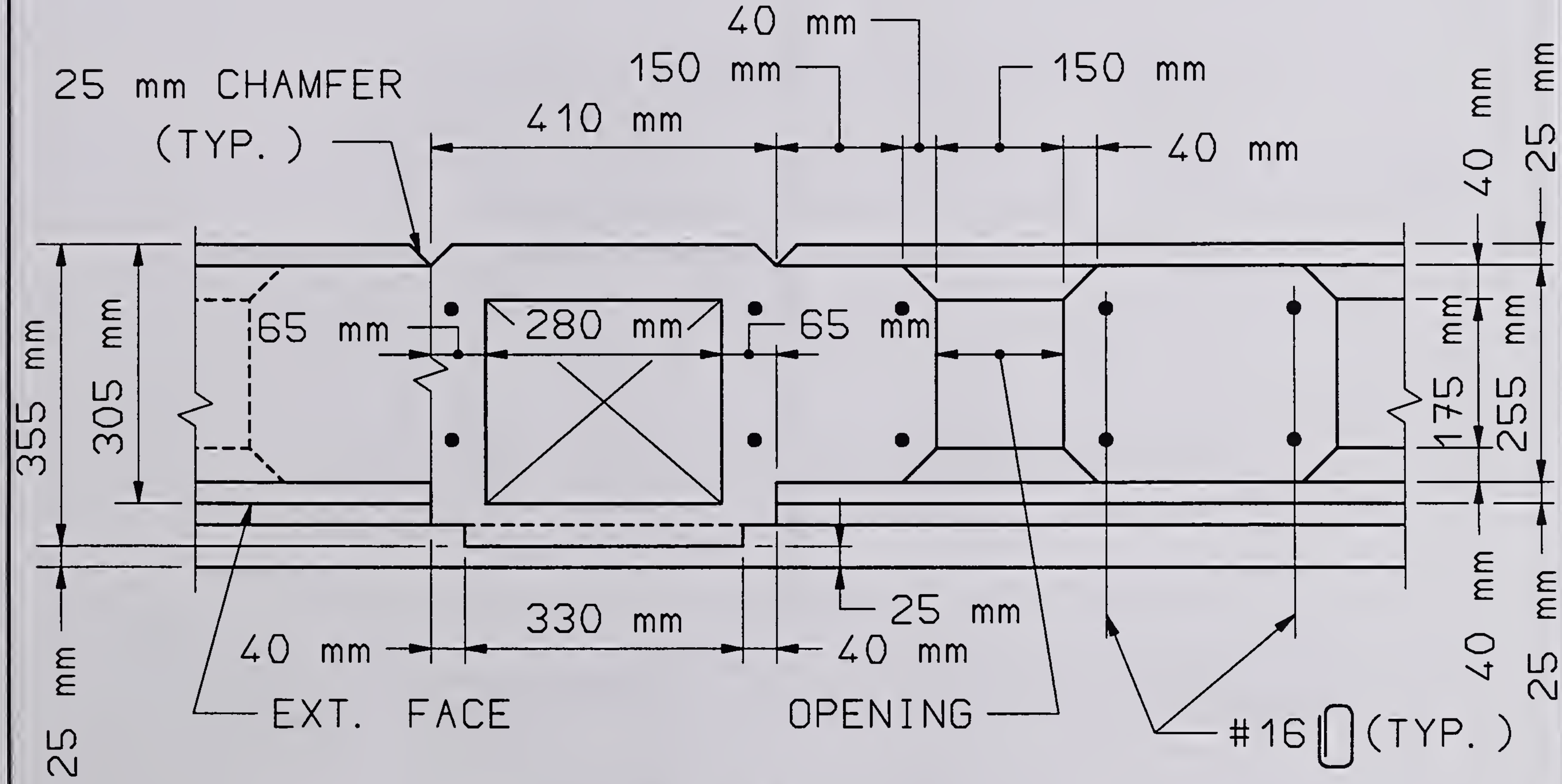
DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.8



SECTION 3

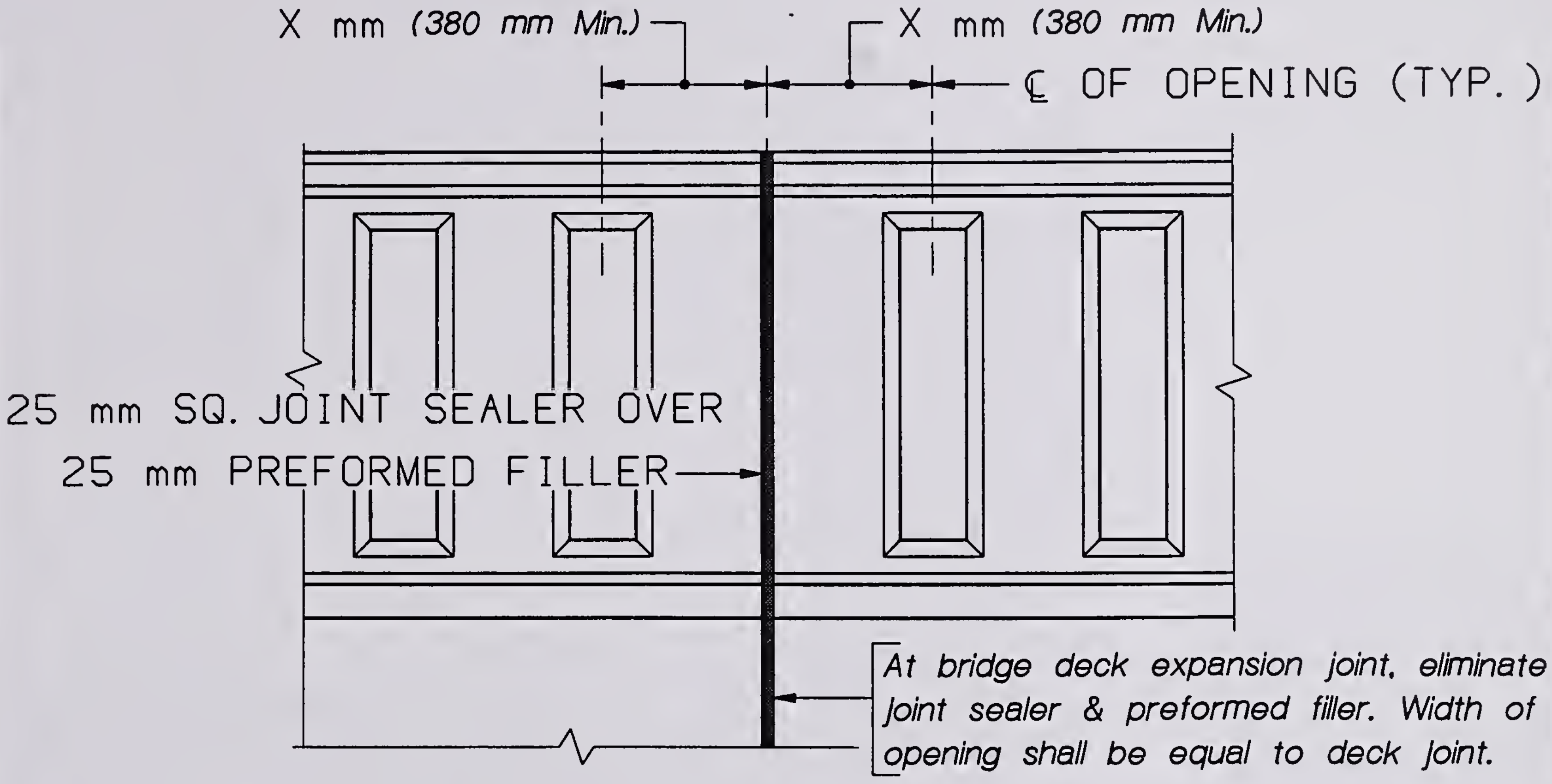
SCALE 1:10



SECTION 4

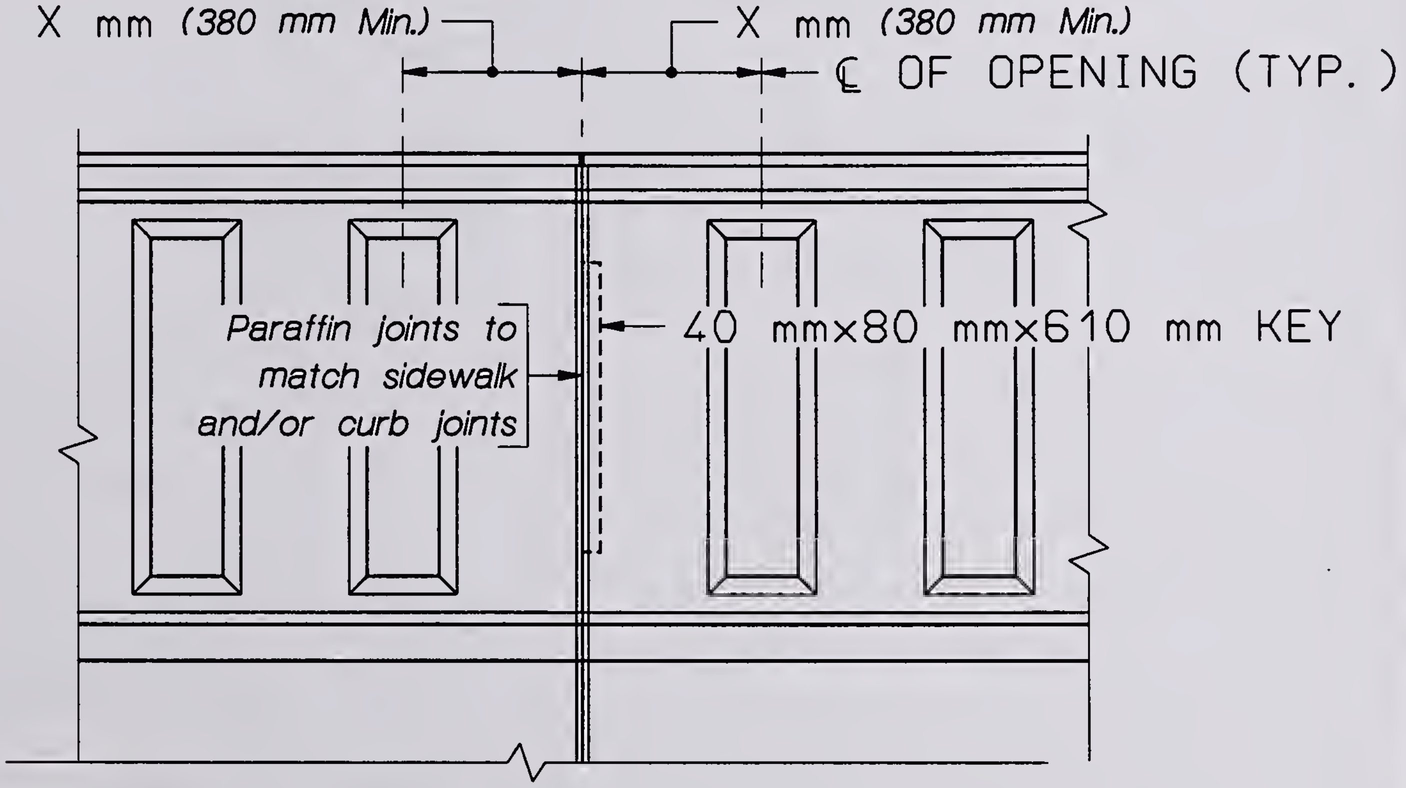
SCALE 1:10

MASSHIGHWAY BRIDGE MANUAL	PLAN SECTIONS OF OPTIONAL PILASTERS CT-PL1* RAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.2.9**



At bridge deck expansion joint, eliminate joint sealer & preformed filler. Width of opening shall be equal to deck joint.

EXPANSION JOINT



Paraffin joints to match sidewalk and/or curb joints

NOTE:

Paraffin joints shall be spaced a minimum of 6.0 m and a maximum of 7.5 m over deck (see dwg. No. 9.8.3) and at construction joints on wingwalls.

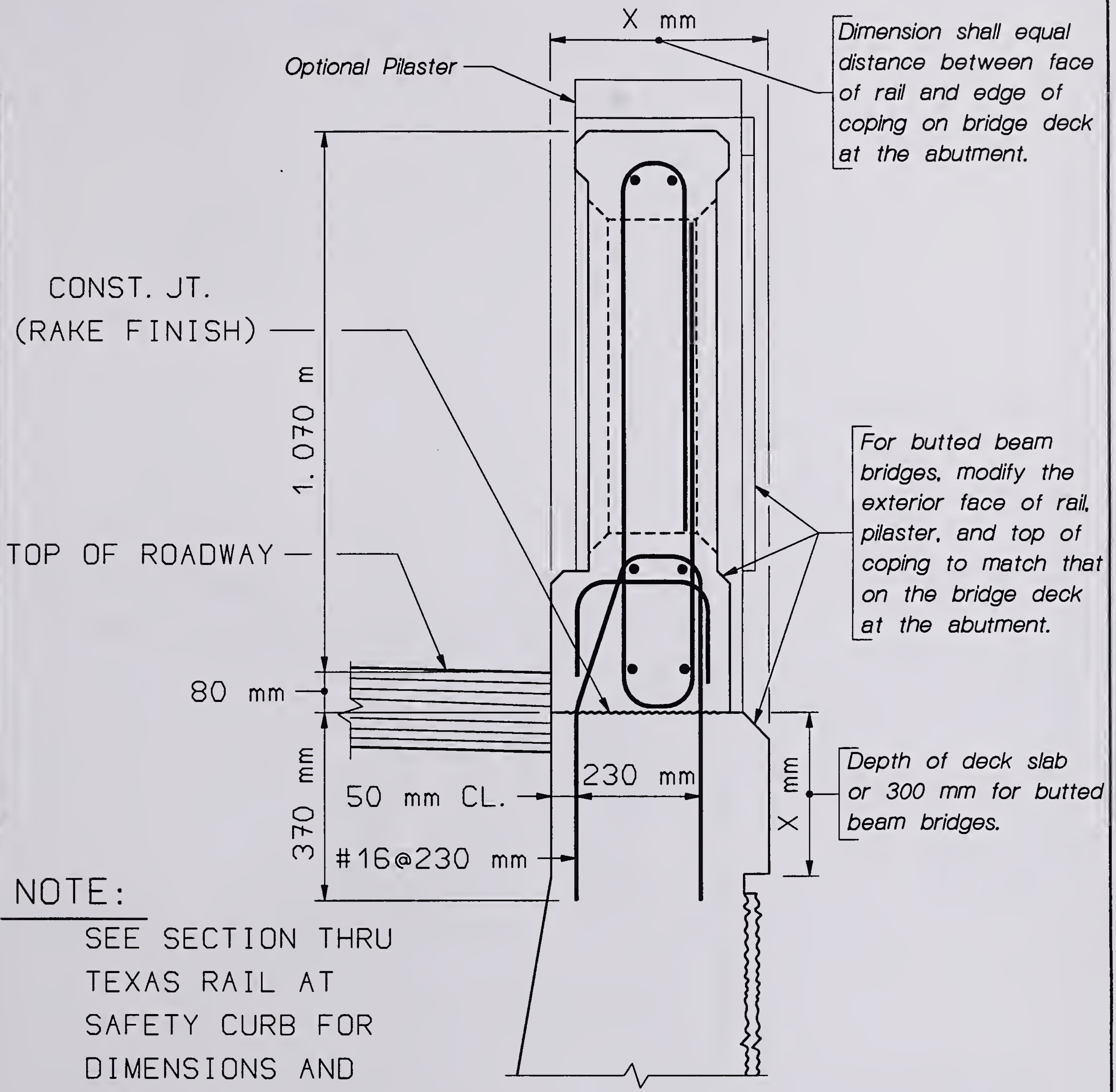
PARAFFIN JOINT

MASSHIGHWAY
BRIDGE
MANUAL

JOINT DETAILS
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.10


X mm
Optional Pilaster
Dimension shall equal distance between face of rail and edge of coping on bridge deck at the abutment.
CONST. JT.
(RAKE FINISH)
1.070 m
TOP OF ROADWAY
For butted beam bridges, modify the exterior face of rail, pilaster, and top of coping to match that on the bridge deck at the abutment.
80 mm
370 mm
230 mm
50 mm CL.
#16@230 mm
X mm
Depth of deck slab or 300 mm for butted beam bridges.

NOTE:

SEE SECTION THRU
TEXAS RAIL AT
SAFETY CURB FOR
DIMENSIONS AND
REINFORCEMENT
NOT SHOWN HERE.

TOP OF WINGWALL DETAILS
AT SAFETY CURB

Draw to 1:10 scale min.

NOTE:

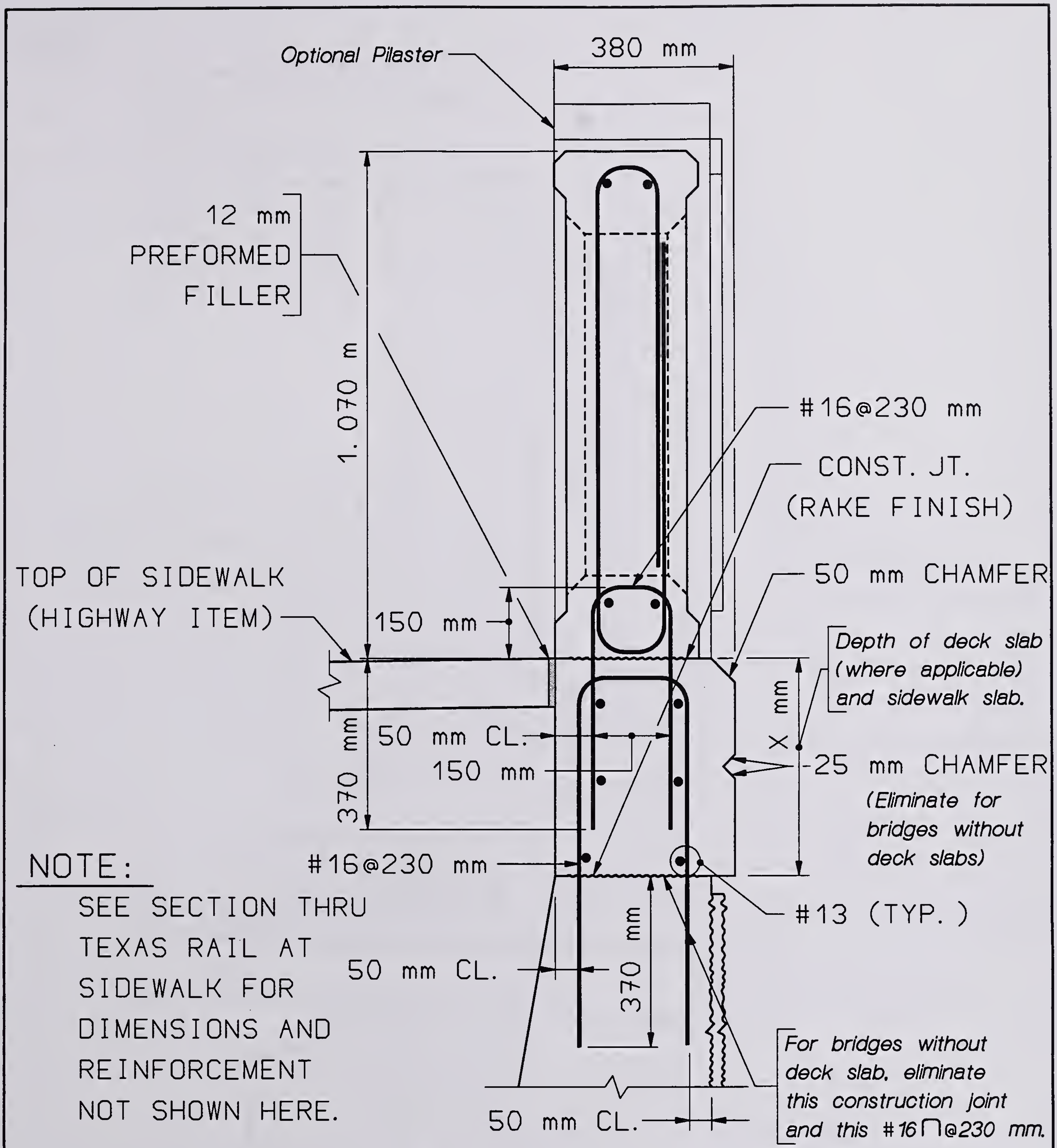
Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY
BRIDGE
MANUAL

TOP OF U-WINGWALL DETAILS
SAFETY CURB SIDE
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.11


Optional Pilaster
380 mm
12 mm PREFORMED FILLER
1.070 m
#16@230 mm
CONST. JT. (RAKE FINISH)
50 mm CHAMFER
TOP OF SIDEWALK (HIGHWAY ITEM)
150 mm
Depth of deck slab (where applicable) and sidewalk slab.
X mm
50 mm CL.
150 mm
370 mm
-25 mm CHAMFER (Eliminate for bridges without deck slabs)
#16@230 mm
#13 (TYP.)
50 mm CL.
370 mm
For bridges without deck slab, eliminate this construction joint and this #16∩@230 mm.
50 mm CL.

NOTE:

SEE SECTION THRU TEXAS RAIL AT SIDEWALK FOR DIMENSIONS AND REINFORCEMENT NOT SHOWN HERE.

TOP OF WINGWALL DETAILS AT SIDEWALK

DRAW TO 1:10 SCALE MIN.

NOTE:

Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY
BRIDGE
MANUAL

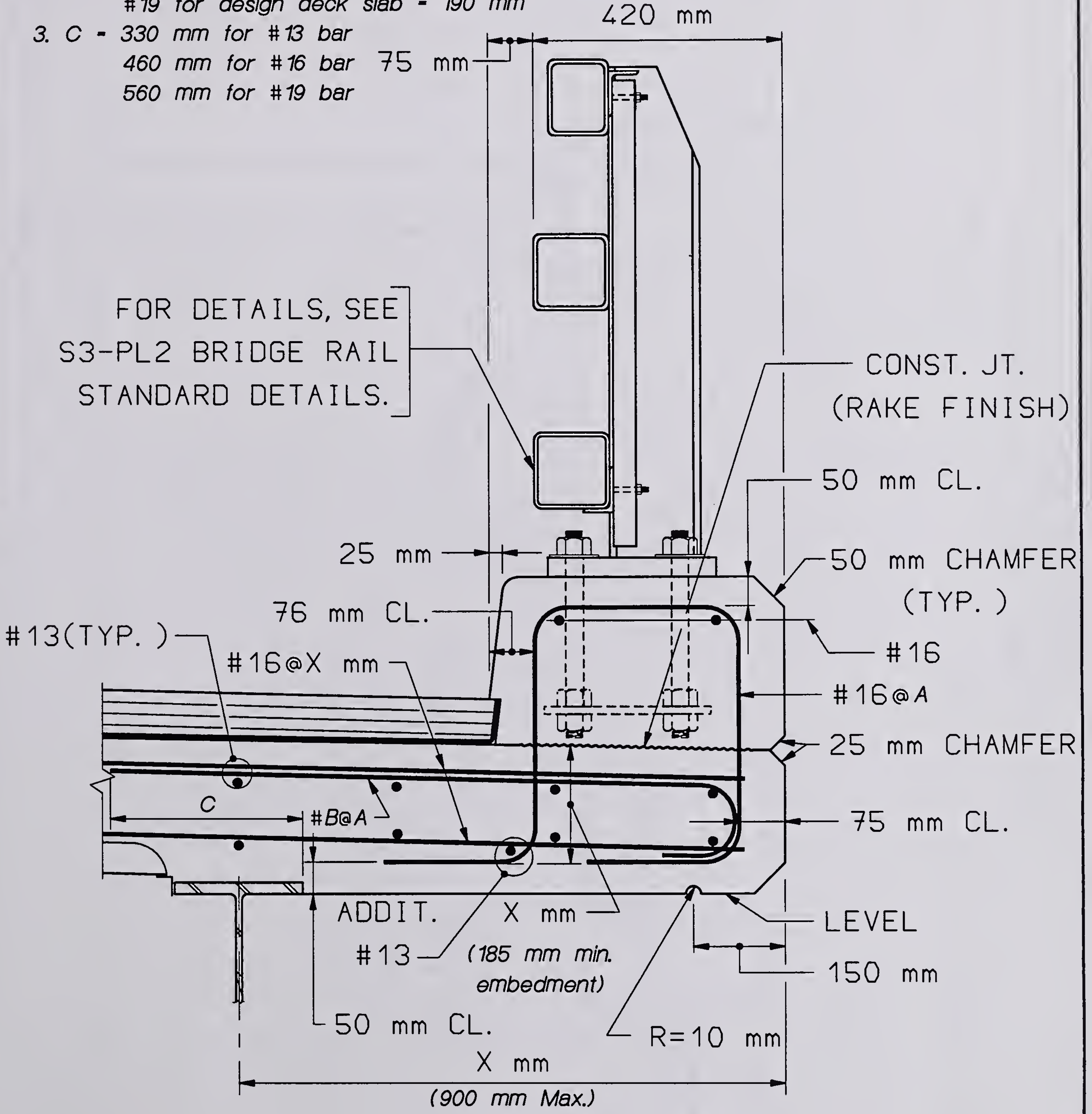
TOP OF U-WINGWALL DETAILS
SIDEWALK SIDE
CT-PL1* RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.2.12

NOTES:

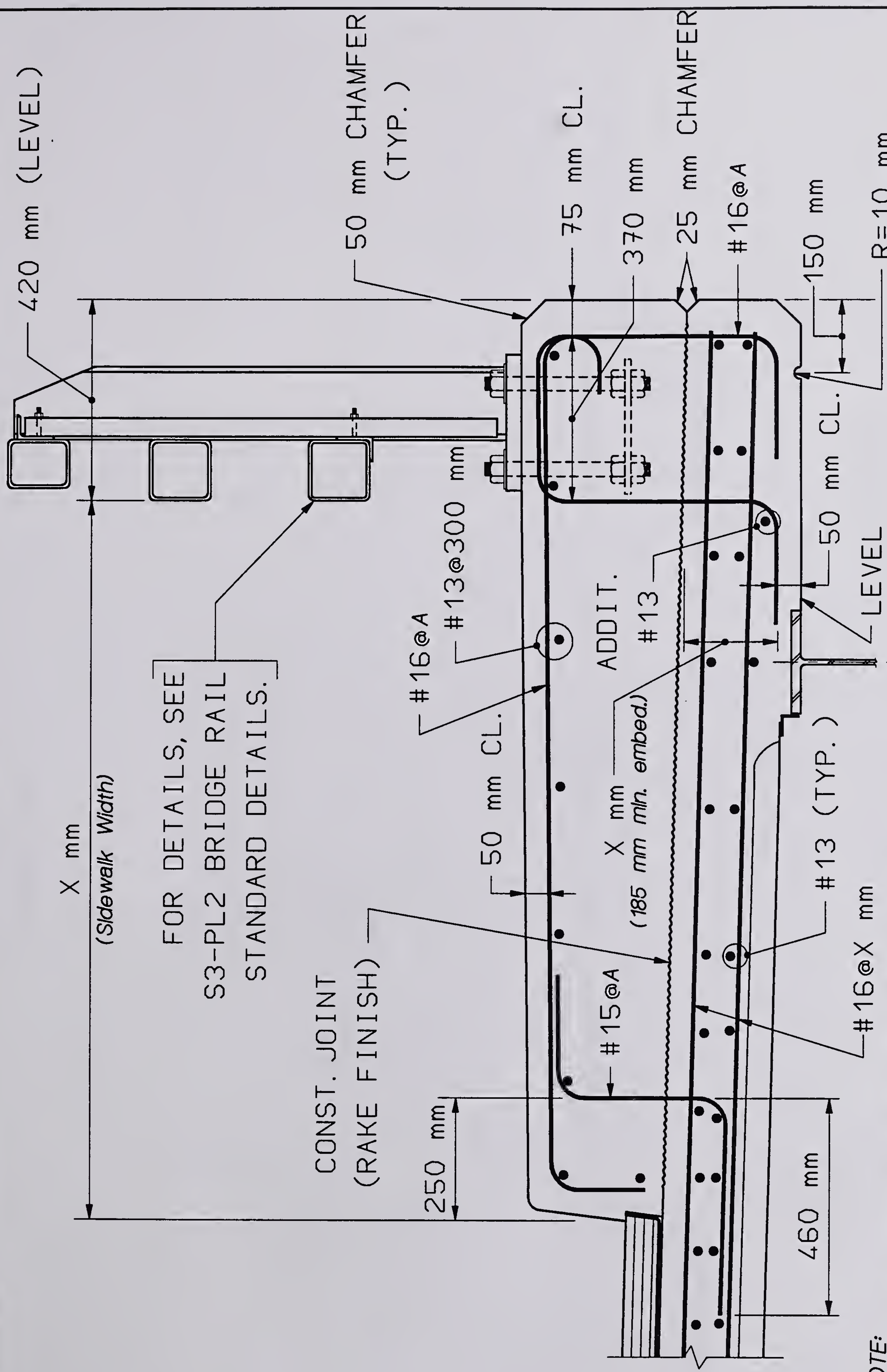
1. *A. - Same spacing as deck slab reinforcement. (215 mm maximum spacing).*
2. *B - #13 for design deck slab - 215 mm*
   #16 for design deck slab - 200 mm
   #19 for design deck slab - 190 mm
3. *C - 330 mm for #13 bar*
   460 mm for #16 bar
   560 mm for #19 bar



SECTION THRU SAFETY CURB

SCALE 1: 10

MASS HIGHWAY BRIDGE MANUAL	SECTION THRU SAFETY CURB S3-PL2 RAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.3.1**



SECTION THRU SIDEWALK

Draw to 1:10 scale min.

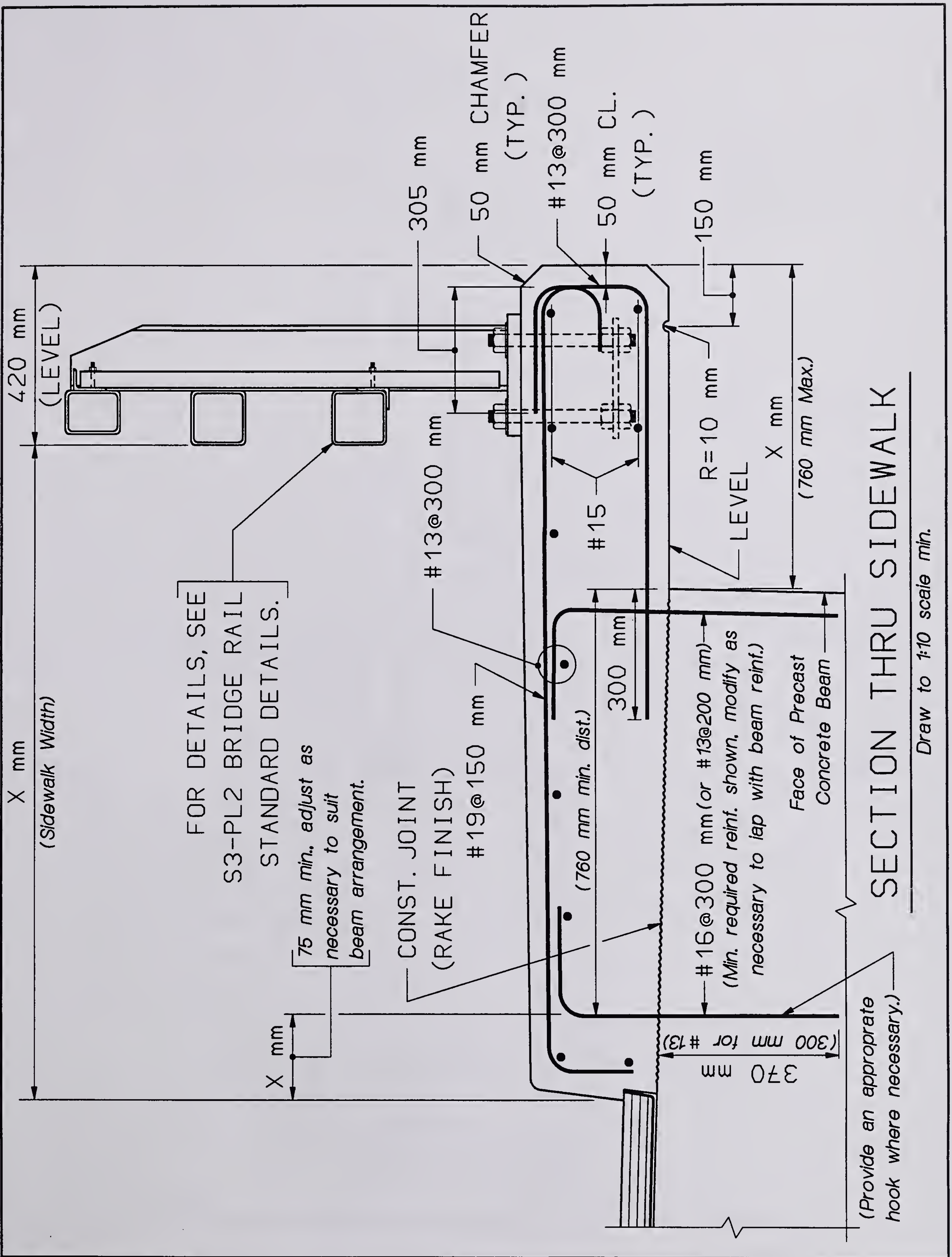
NOTE:
A - Same spacing as deck slab reinforcement. (215 mm maximum spacing.)

MASS HIGHWAY
BRIDGE MANUAL

SECTION THRU SIDEWALK
S3-PL2 RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.3.2



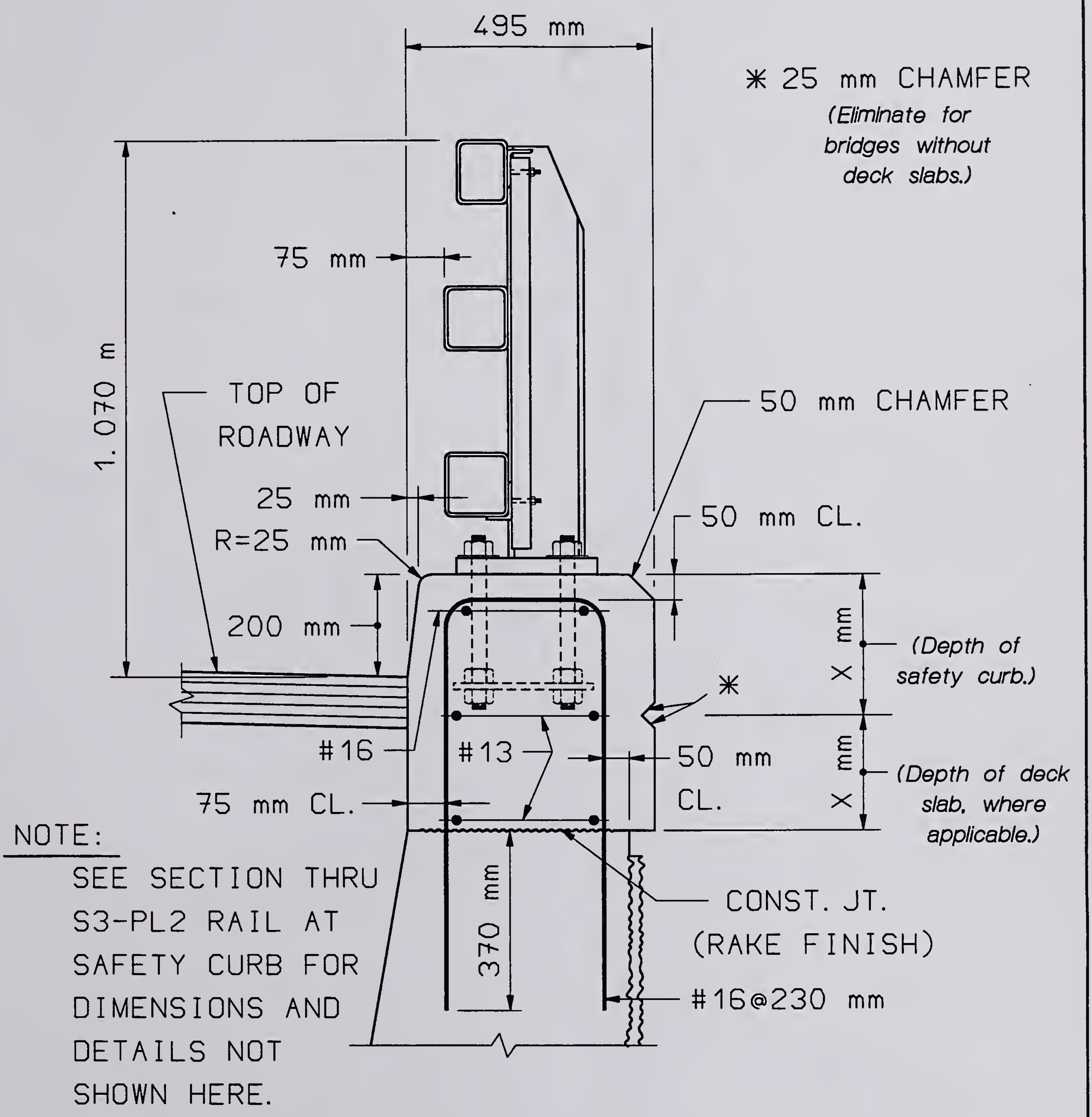
MASS HIGHWAY
BRIDGE
MANUAL

SECTION THRU OVERHANGING SIDEWALK

S3-PL2 RAIL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.3.3



NOTE:

SEE SECTION THRU S3-PL2 RAIL AT SAFETY CURB FOR DIMENSIONS AND DETAILS NOT SHOWN HERE.

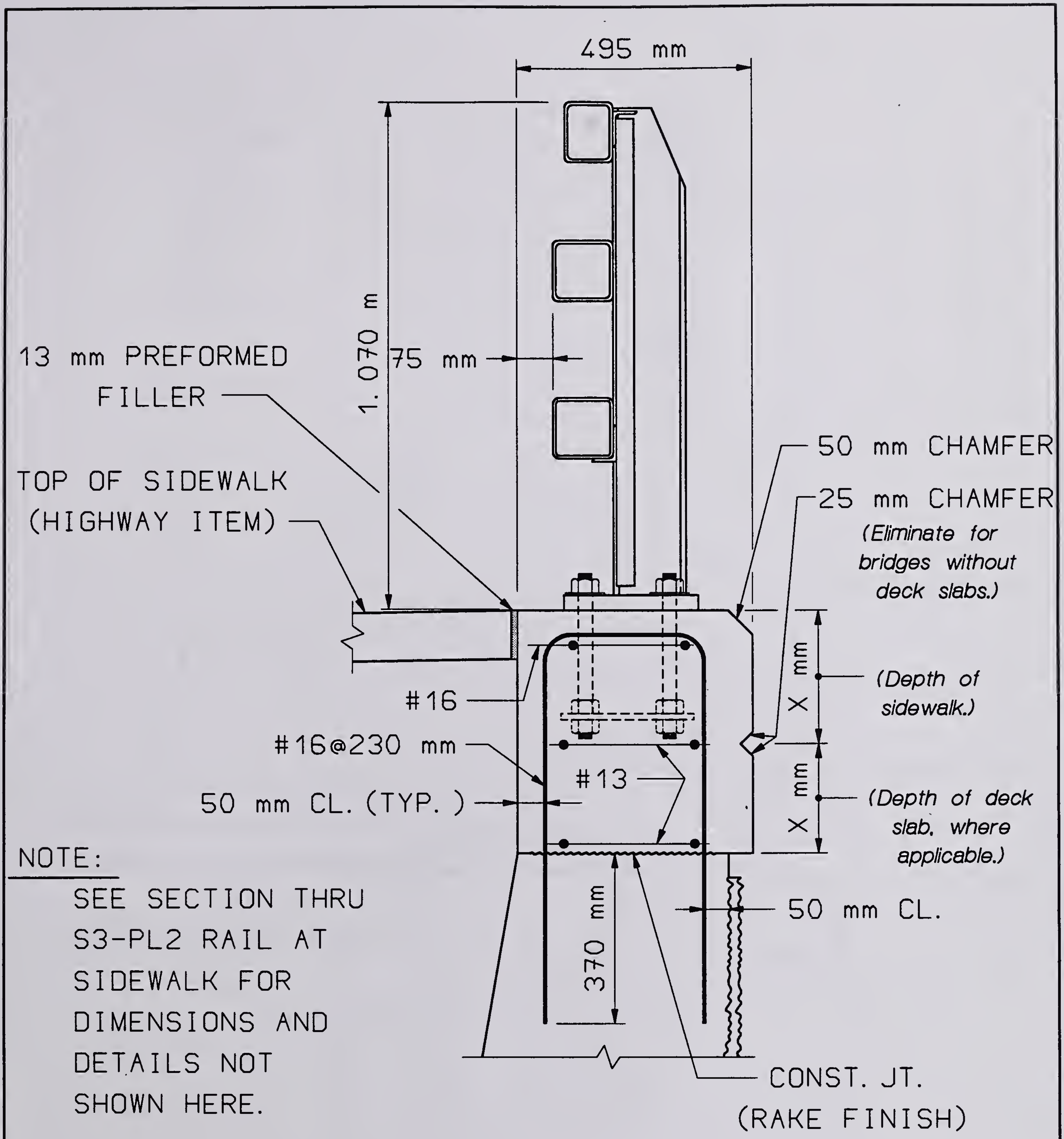
TOP OF WINGWALL DETAILS
AT SAFETY CURB

Draw to 1:10 scale min.

NOTE:

Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY BRIDGE MANUAL	TOP OF U-WINGWALL DETAILS SAFETY CURB SIDE S3-PL2 RAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.3.4**



NOTE:

SEE SECTION THRU S3-PL2 RAIL AT SIDEWALK FOR DIMENSIONS AND DETAILS NOT SHOWN HERE.

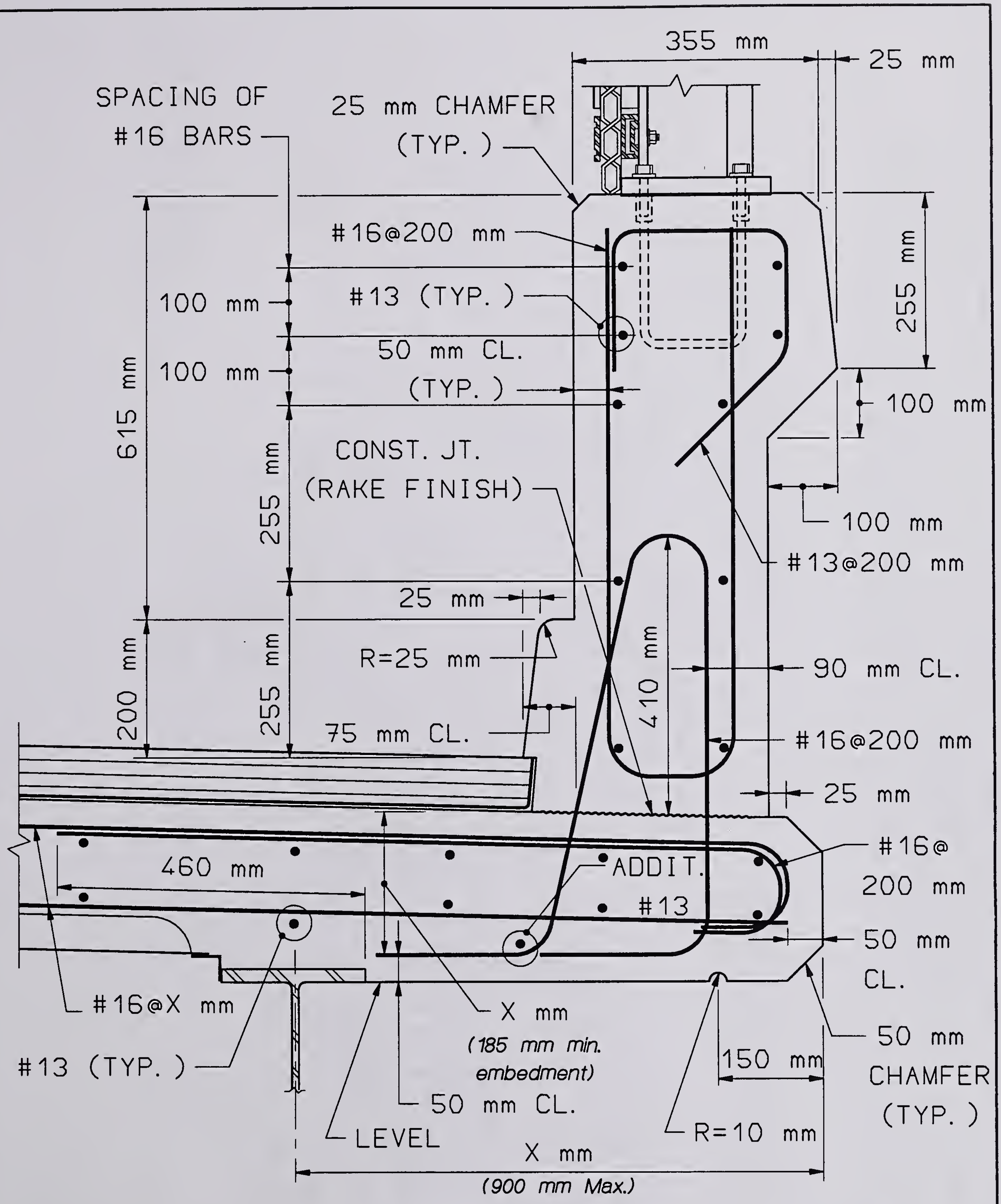
TOP OF WINGWALL DETAILS AT SIDEWALK

Draw to 1:10 scale min.

NOTE:

Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY BRIDGE MANUAL	TOP OF U-WINGWALL DETAILS SIDEWALK SIDE S3-PL2 RAIL	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.3.5**



SECT. THRU PARAPET WALL AT SAFETY CURB

Draw to 1:10 scale min.

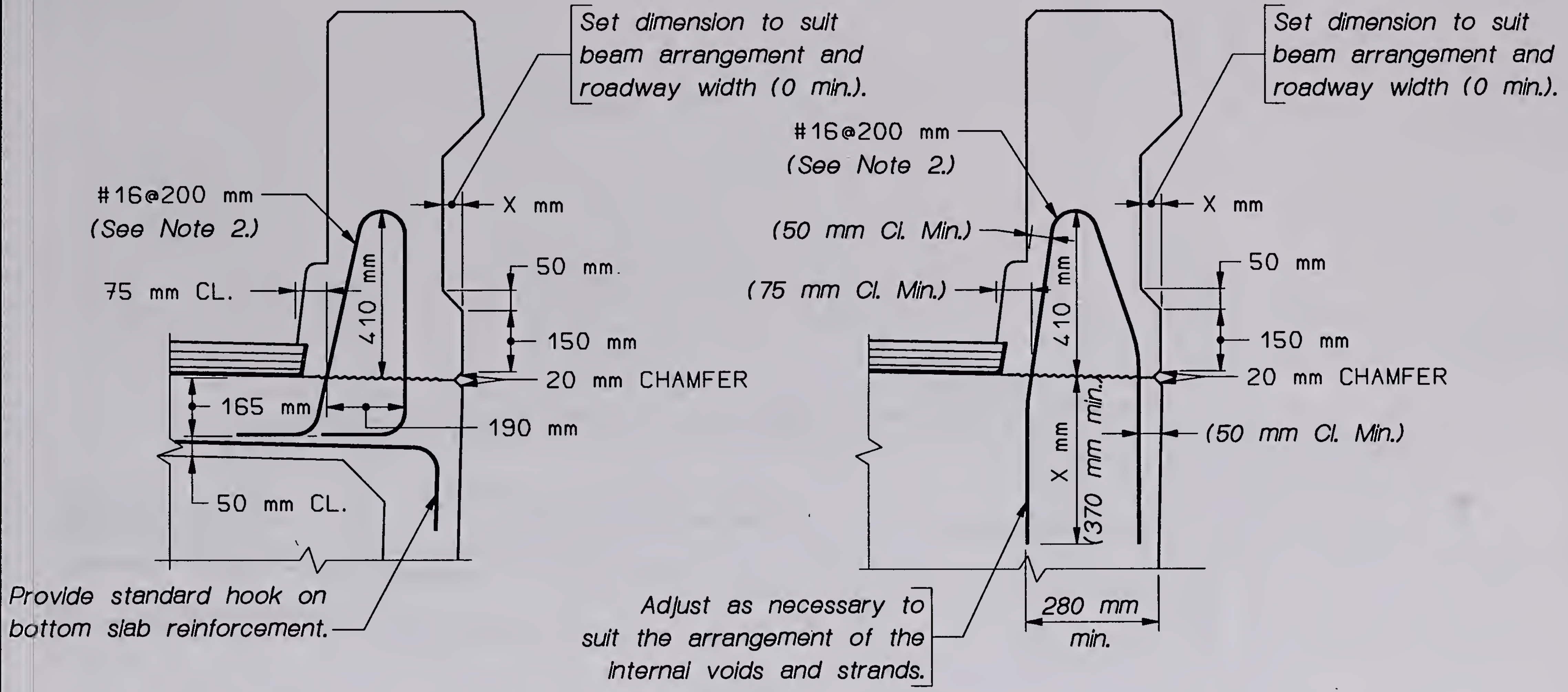
MASS HIGHWAY
BRIDGE
MANUAL

DETAILS AT SAFETY CURB

CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.4.1


Set dimension to suit beam arrangement and roadway width (0 min.).
#16@200 mm (See Note 2.)
X mm
75 mm CL.
410 mm
50 mm.
150 mm
20 mm CHAMFER
165 mm
190 mm
50 mm CL.
Provide standard hook on bottom slab reinforcement.
Set dimension to suit beam arrangement and roadway width (0 min.).
#16@200 mm (See Note 2.)
(50 mm Cl. Min.)
(75 mm Cl. Min.)
X mm
410 mm
50 mm
150 mm
20 mm CHAMFER
(50 mm Cl. Min.)
X mm
(370 mm min.)
280 mm min.
Adjust as necessary to suit the arrangement of the internal voids and strands.

SECTION THRU BARRIER

(SI & BI MOD. - BIV MOD. BEAMS)

SECTION THRU BARRIER

(SII - SIV BEAMS)

NOTES:

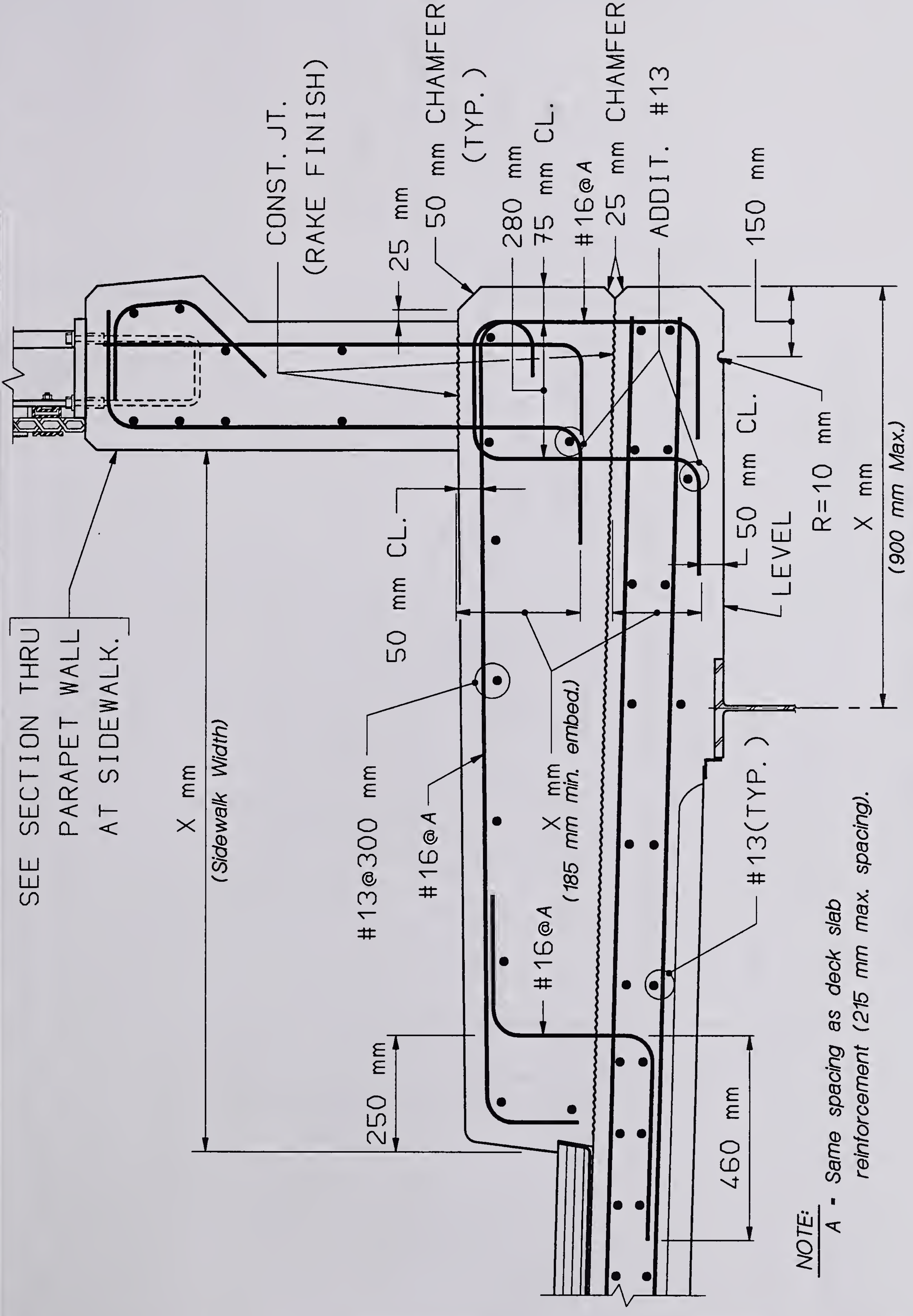
1. Modify the width and reinforcement of the "Section Thru Parapet Wall at Safety Curb" (Dwg. No. 9.4.1), to the extent shown above, to suit the arrangement of the butted beams, the internal voids, and the strands.
2. Bars extending from the top of the beams shall be spaced at multpes of beam reinforcement and shall provide no less than #16@200 mm reinforcement.

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR PRECAST
BUTTED BEAM BRIDGES
CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.4.2

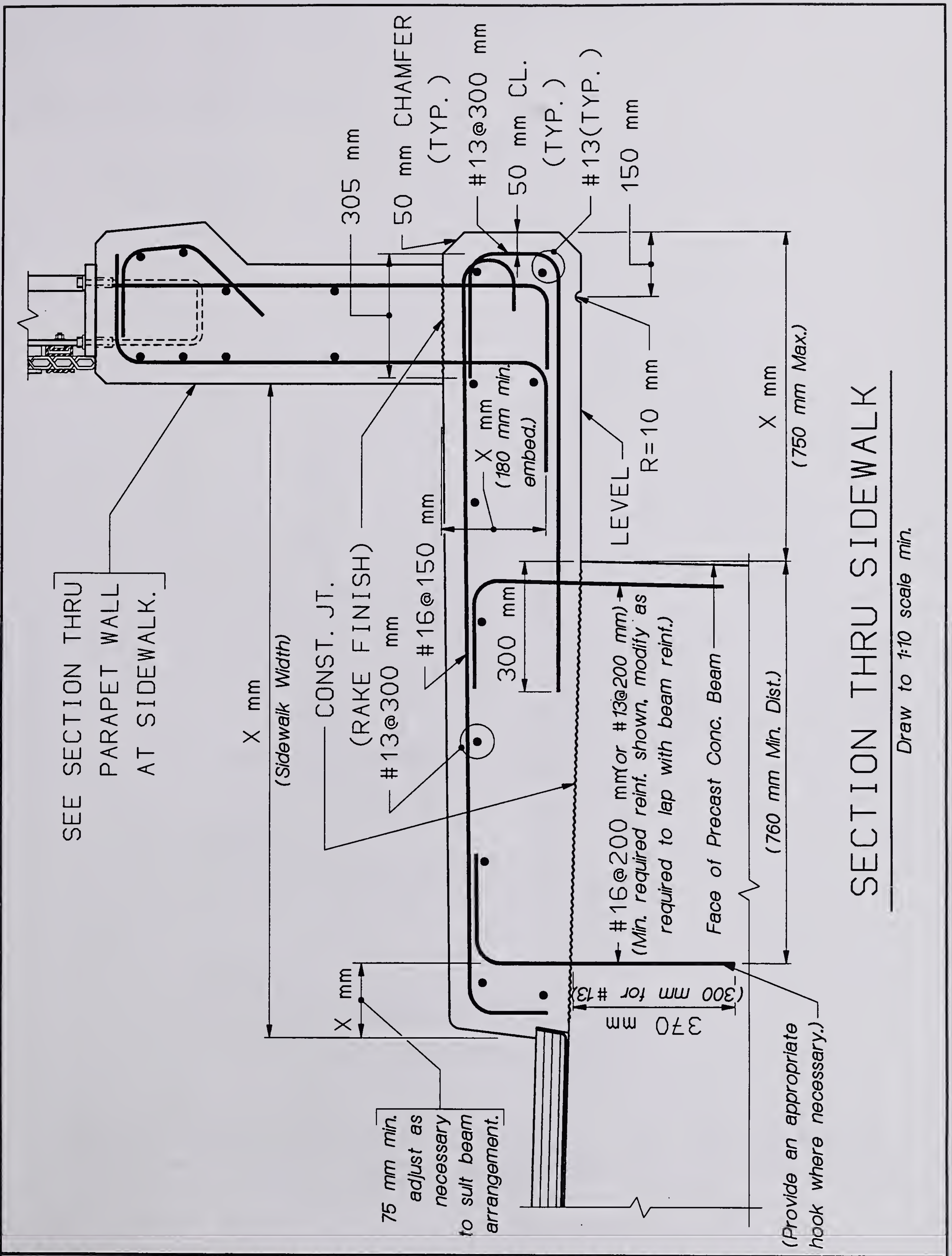


NOTE:
A - Same spacing as deck slab reinforcement (215 mm max. spacing).

SECTION THRU SIDEWALK

Draw to 1:10 scale min.

MASS HIGHWAY BRIDGE MANUAL	SECTION THRU SIDEWALK CP-PL2 BARRIER	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.4.3**

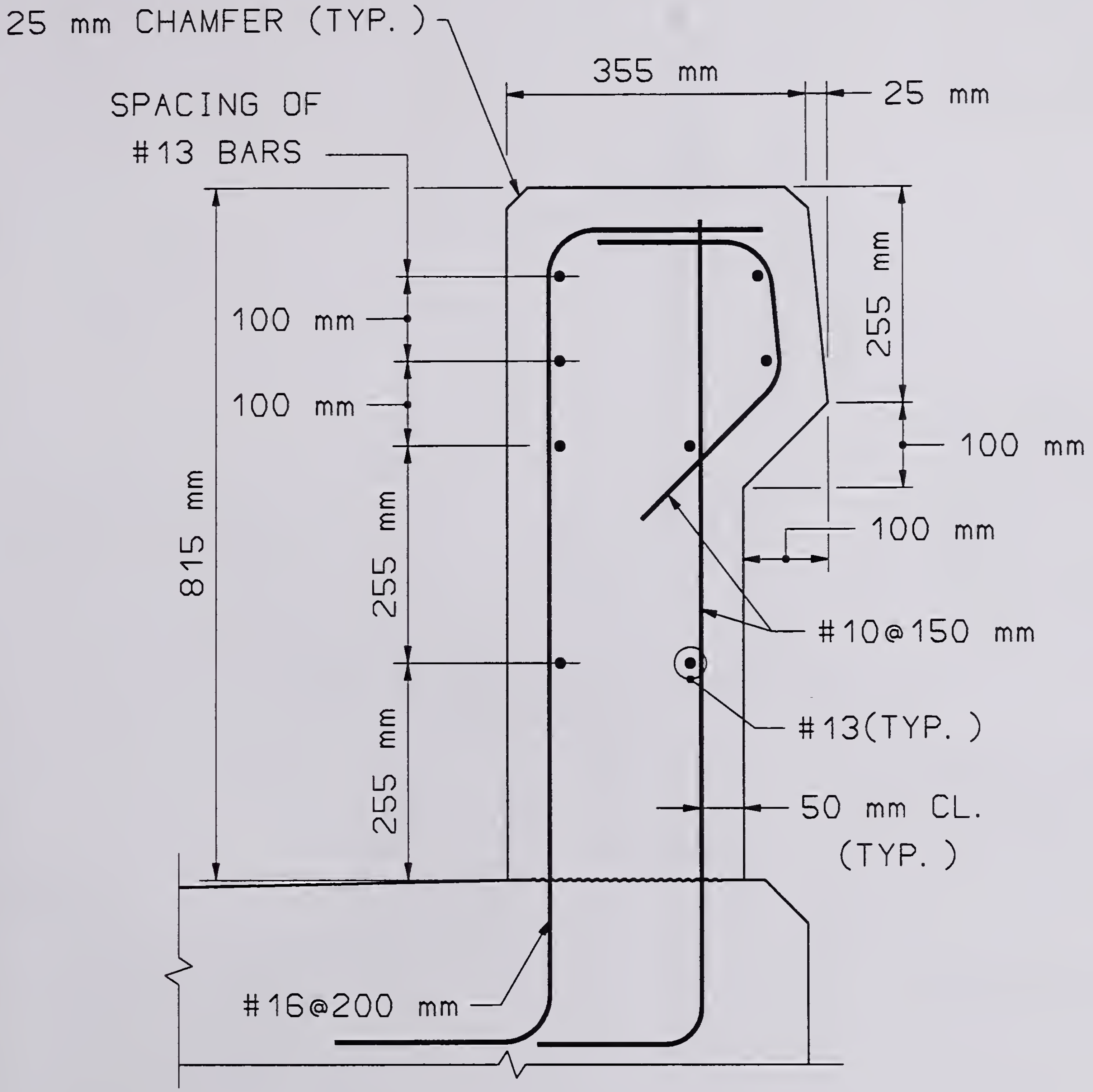


MASS HIGHWAY
BRIDGE MANUAL

SECTION THRU OVERHANGING SIDEWALK
CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.4.4



NOTE:

FOR SIDEWALK REINFORCEMENT
SEE SECTION THRU SIDEWALK.

SECT. THRU PARAPET WALL AT SIDEWALK

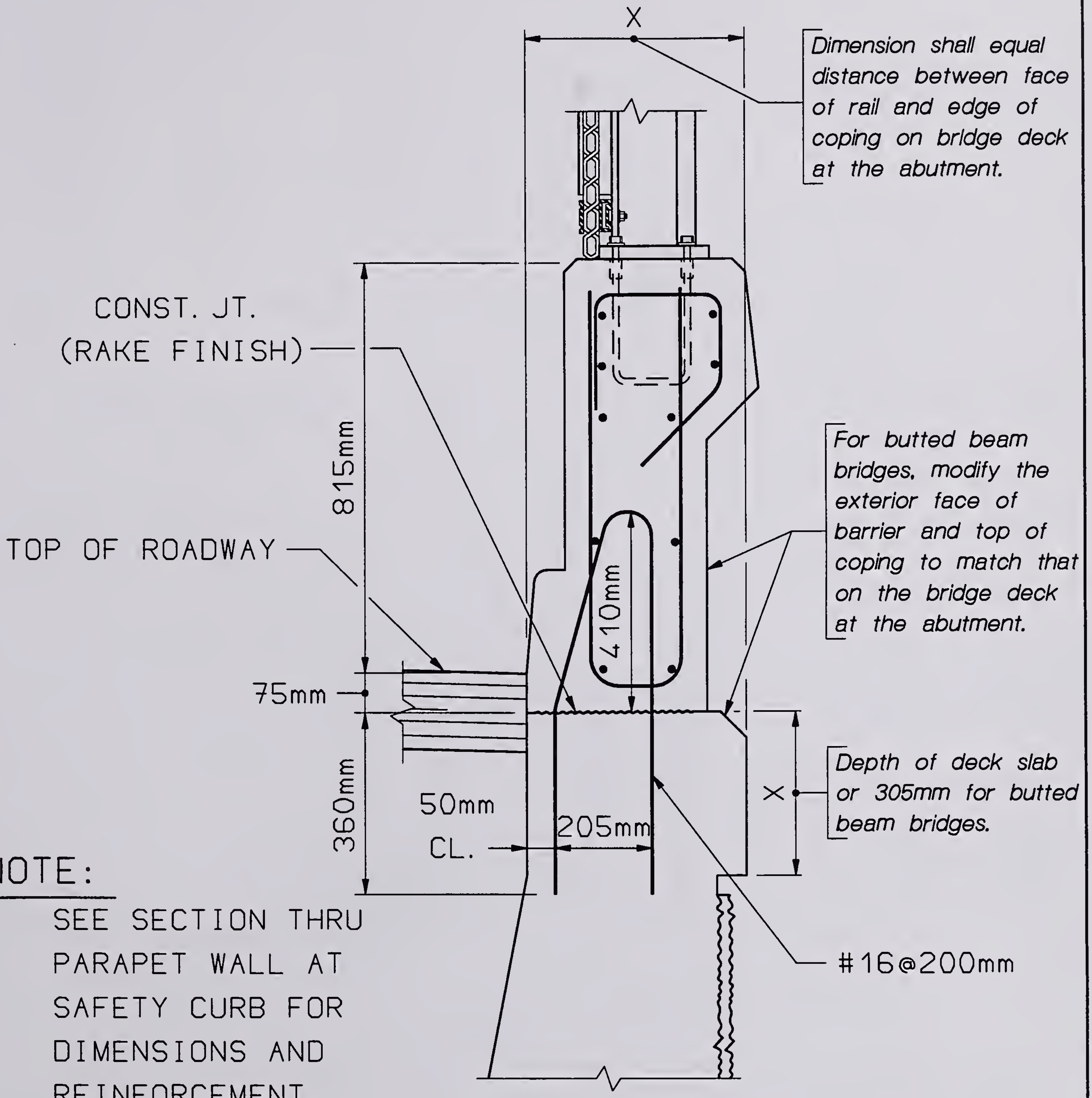
Draw to 1:10 scale min.

MASS HIGHWAY
BRIDGE MANUAL

DETAILS AT SIDEWALK
CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.4.5



Dimension shall equal distance between face of rail and edge of coping on bridge deck at the abutment.

For butted beam bridges, modify the exterior face of barrier and top of coping to match that on the bridge deck at the abutment.

Depth of deck slab or 305mm for butted beam bridges.

NOTE:

SEE SECTION THRU PARAPET WALL AT SAFETY CURB FOR DIMENSIONS AND REINFORCEMENT NOT SHOWN HERE.

TOP OF WINGWALL DETAILS
AT SAFETY CURB

Draw to 1:10 scale min.

NOTE:

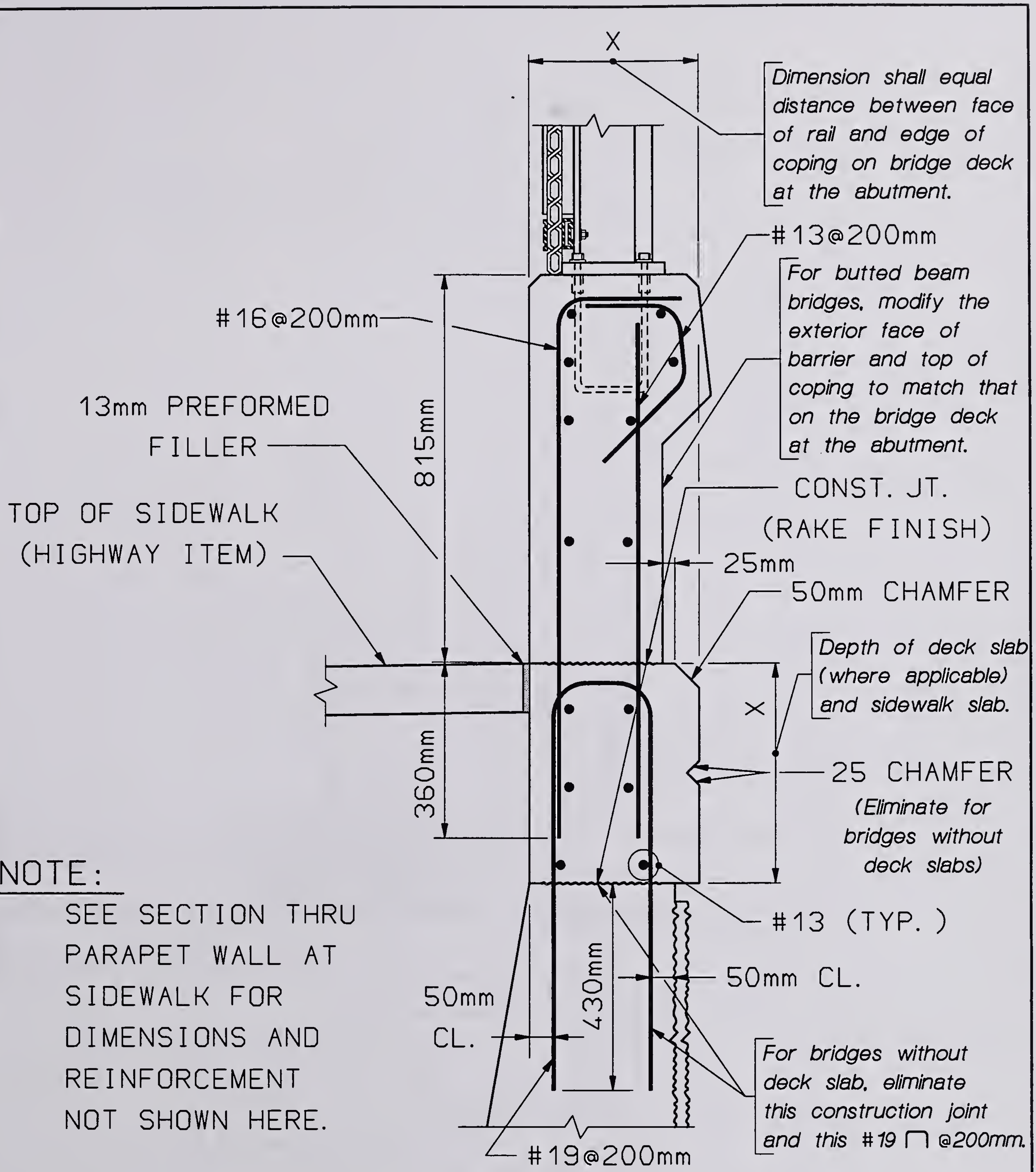
Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY
BRIDGE
MANUAL

TOP OF U-WINGWALL DETAILS
SAFETY CURB SIDE
CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.4.6



Dimension shall equal distance between face of rail and edge of coping on bridge deck at the abutment.

For butted beam bridges, modify the exterior face of barrier and top of coping to match that on the bridge deck at the abutment.

Depth of deck slab (where applicable) and sidewalk slab.

(Eliminate for bridges without deck slabs)

For bridges without deck slab, eliminate this construction joint and this #19 ⊓ @200mm.

NOTE:

SEE SECTION THRU PARAPET WALL AT SIDEWALK FOR DIMENSIONS AND REINFORCEMENT NOT SHOWN HERE.

TOP OF WINGWALL DETAILS AT SIDEWALK

Draw to 1:10 scale min.

NOTE:

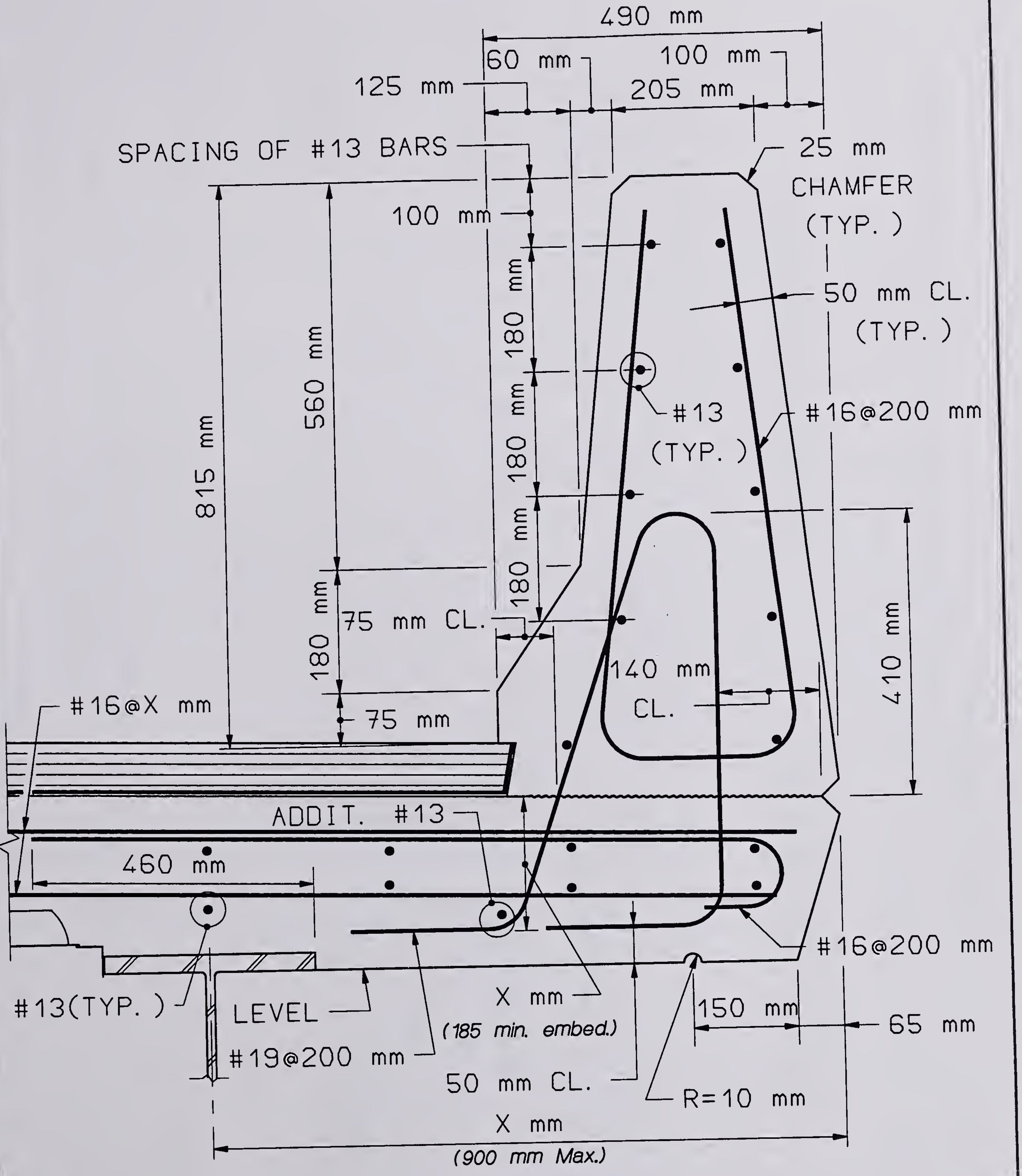
Include and label all reinforcement at the top of the wingwall.

MASS HIGHWAY
BRIDGE
MANUAL

TOP OF U-WINGWALL DETAILS
SIDEWALK SIDE
CP-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

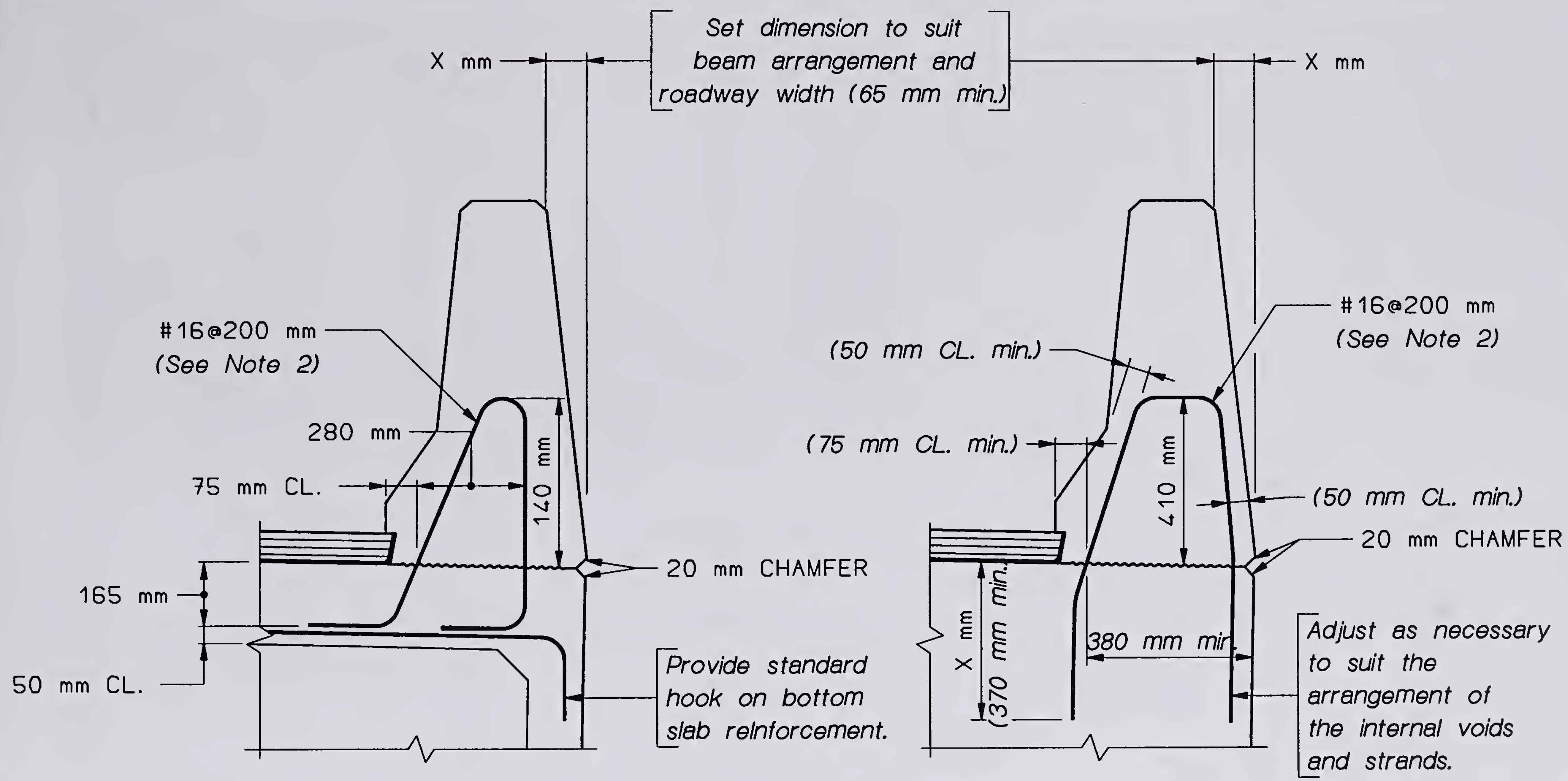
DRAWING NUMBER
9.4.7



SECTION THRU CF-PL2 BARRIER

Draw to 1:10 scale min.

MASS HIGHWAY BRIDGE MANUAL	TYPICAL SECTION CF-PL2 BARRIER	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.5.1**



SECTION THRU BARRIER
(SI & BI MOD. - BIV MOD. BEAMS)

SECTION THRU BARRIER
(SII - SIV BEAMS)

NOTES:

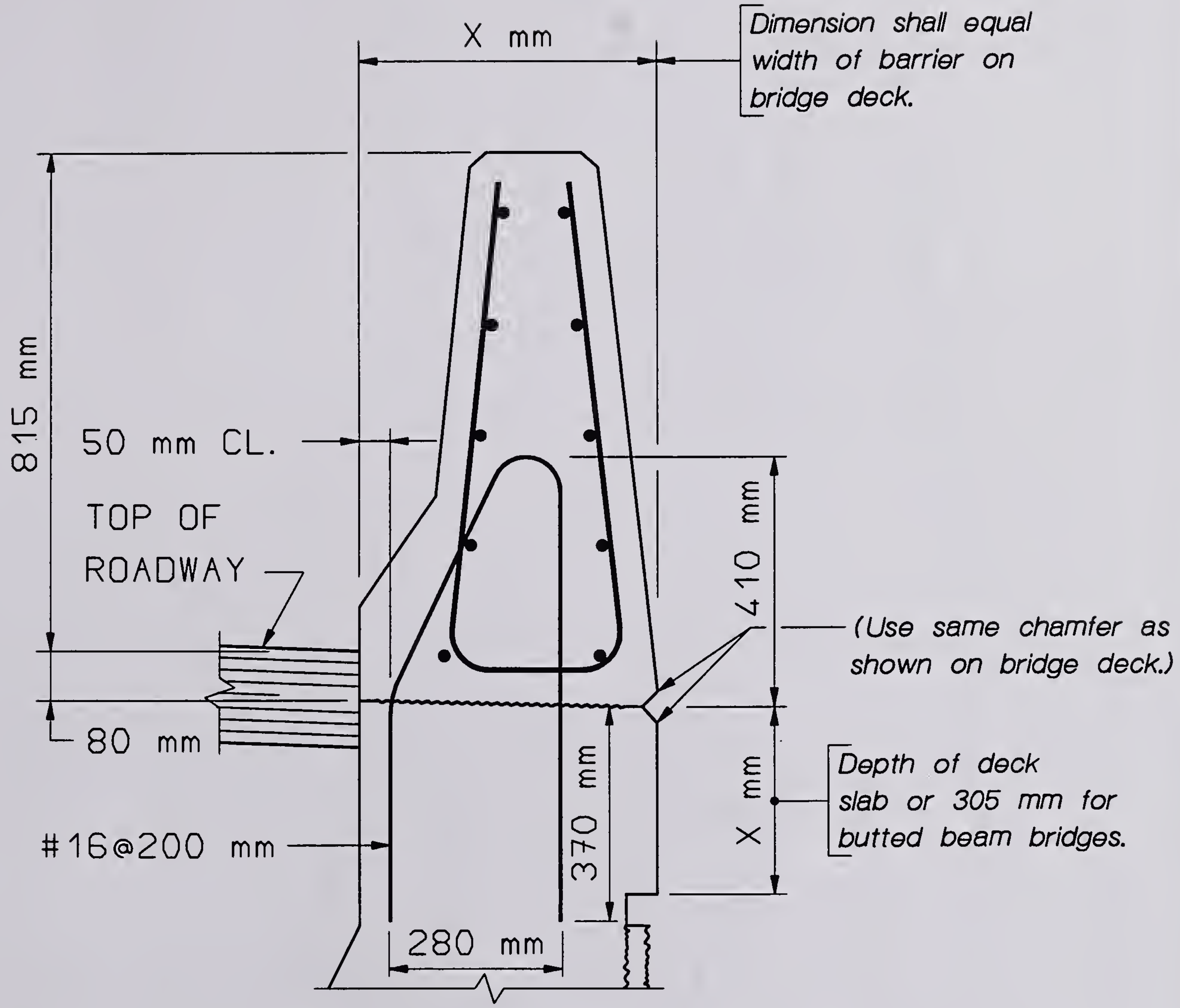
1. Modify the width and reinforcement of the "Section Thru CF-PL2 Barrier" (Dwg. No. 9.5.1), to the extent shown above, to suit the arrangement of the butted beams, the internal voids, and the strands.
2. Bars extending from the top of the beams shall be spaced at multiples of beam reinforcement and shall provide no less than #16@200 mm reinforcement.

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR PRECAST
BUTTED BEAM BRIDGES
CF-PL2 BARRIER

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.5.2


X mm
Dimension shall equal width of barrier on bridge deck.
815 mm
50 mm CL.
TOP OF ROADWAY
410 mm
(Use same chamfer as shown on bridge deck.)
80 mm
X mm
Depth of deck slab or 305 mm for butted beam bridges.
#16@200 mm
370 mm
280 mm

NOTE:

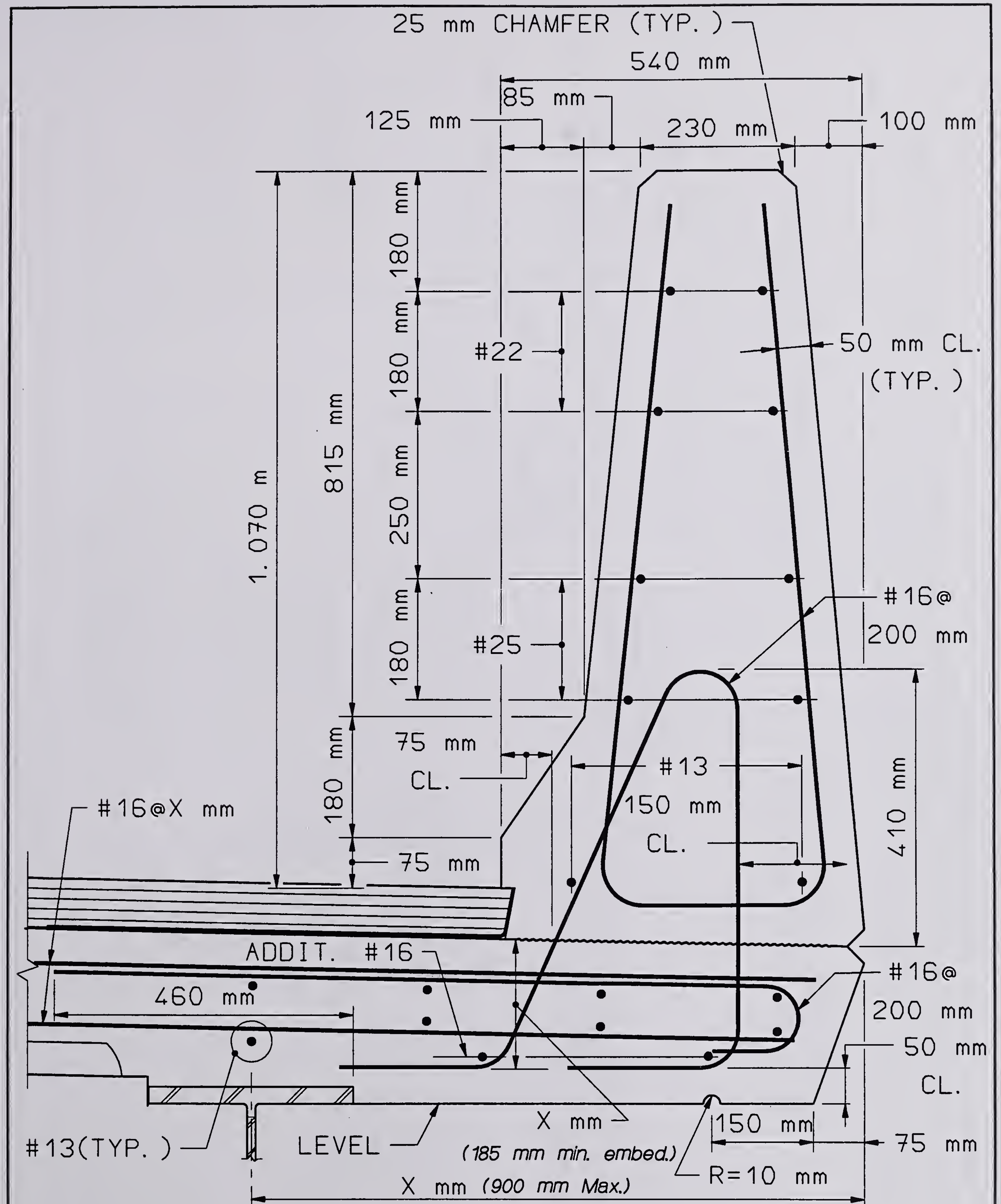
SEE SECTION THRU BARRIER FOR DIMENSIONS AND REINFORCEMENT NOT SHOWN HERE.

TOP OF WINGWALL DETAILS

NOTE:

Include and label all reinforcement at the top of the wingwall.

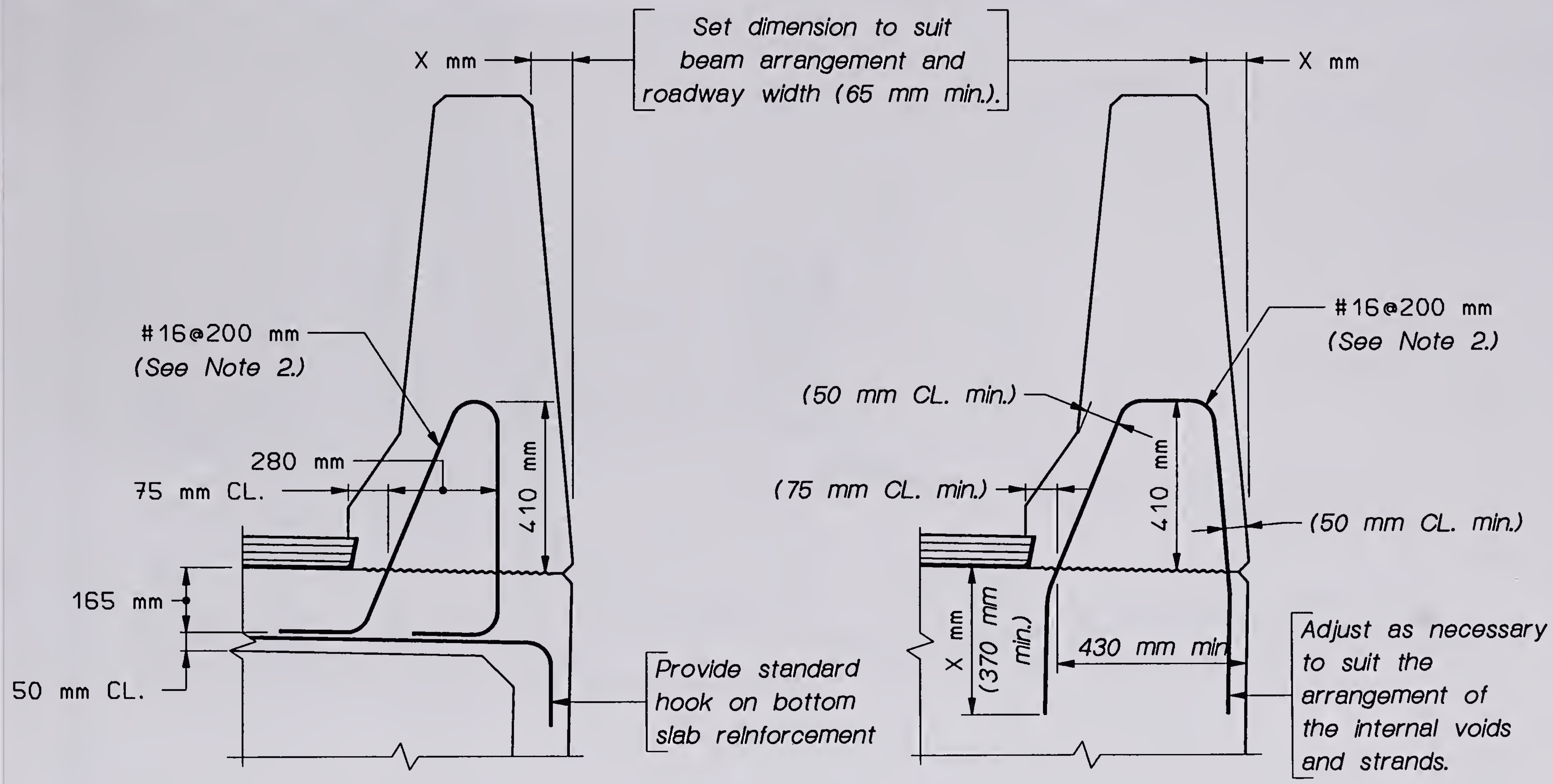
MASS HIGHWAY BRIDGE MANUAL	TOP OF U-WINGWALL DETAILS CF-PL2 BARRIER	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **9.5.3**



SECTION THRU CF-PL3 BARRIER

Draw to 1:10 scale min.

MASS HIGHWAY BRIDGE MANUAL	TYPICAL SECTION CF-PL3 BARRIER	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.6.1**


X mm
Set dimension to suit beam arrangement and roadway width (65 mm min.).
X mm
#16@200 mm (See Note 2.)
280 mm
75 mm CL.
410 mm
165 mm
50 mm CL.
Provide standard hook on bottom slab reinforcement
(50 mm CL. min.)
(75 mm CL. min.)
410 mm
#16@200 mm (See Note 2.)
(50 mm CL. min.)
X mm (370 mm min.)
430 mm min
Adjust as necessary to suit the arrangement of the internal voids and strands.

SECTION THRU BARRIER

(SI & BI MOD. - BIV MOD. BEAMS)

SECTION THRU BARRIER

(SII - SIV BEAMS)

NOTES:

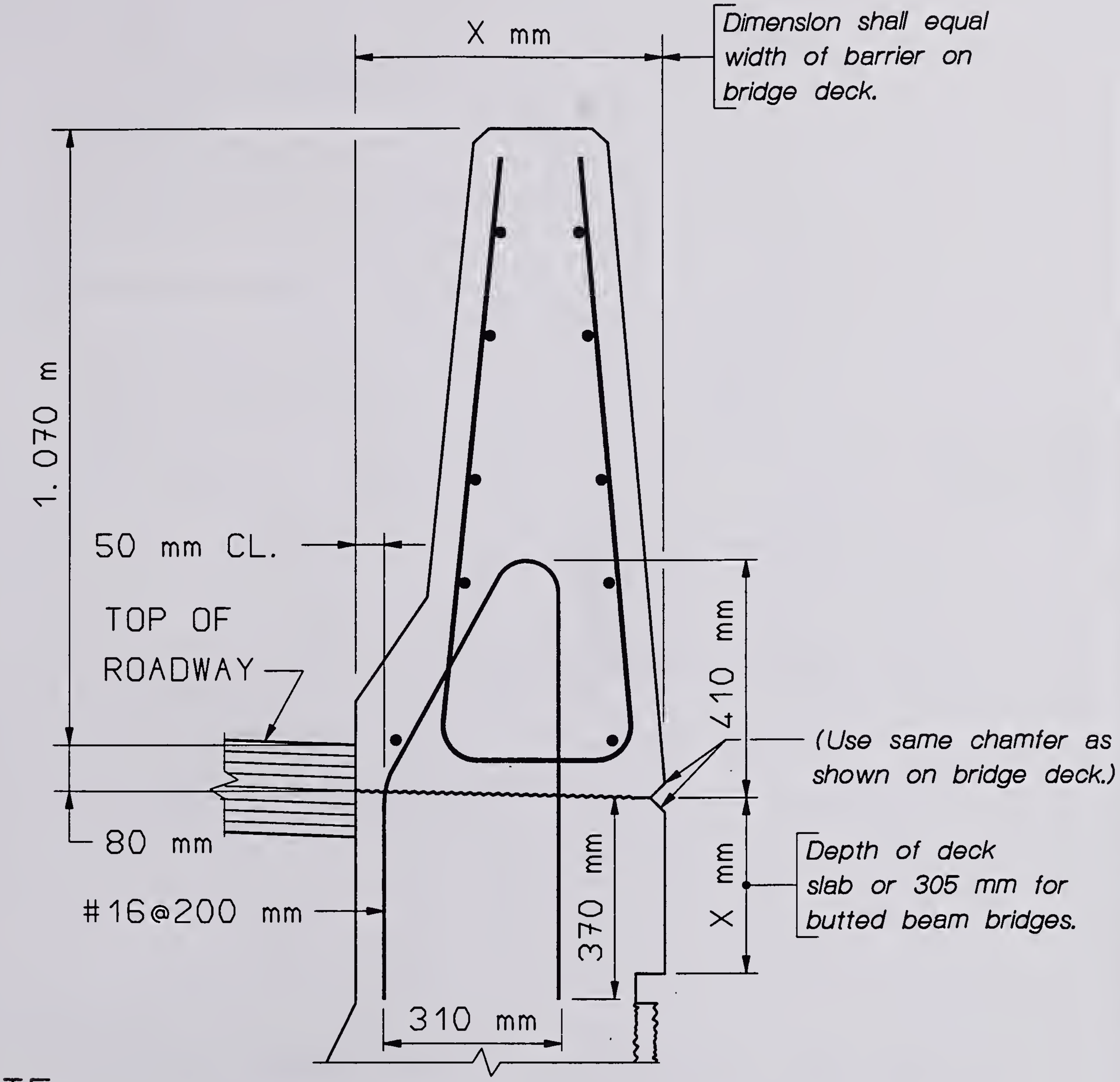
1. Modify the width and reinforcement of the "Section Thru CF-PL3 Barrier" (Dwg. No. 9.6.1), to the extent shown above, to suit the arrangement of the butted beams, the internal voids, and the strands.
2. Bars extending from the top of the beams shall be spaced at multiples of beam reinforcement and shall provide no less than #16@200 mm reinforcement.

MASS HIGHWAY
BRIDGE
MANUAL

MODIFICATIONS FOR PRECAST
BUTTED BEAM BRIDGES
CF-PL3

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
9.6.2


X mm
Dimension shall equal width of barrier on bridge deck.
1.070 m
50 mm CL.
TOP OF ROADWAY
80 mm
#16@200 mm
410 mm
(Use same chamfer as shown on bridge deck.)
370 mm
X mm
Depth of deck slab or 305 mm for butted beam bridges.
310 mm

NOTE:

SEE SECTION THRU BARRIER FOR DIMENSIONS AND REINFORCEMENT NOT SHOWN HERE.

TOP OF WINGWALL DETAILS

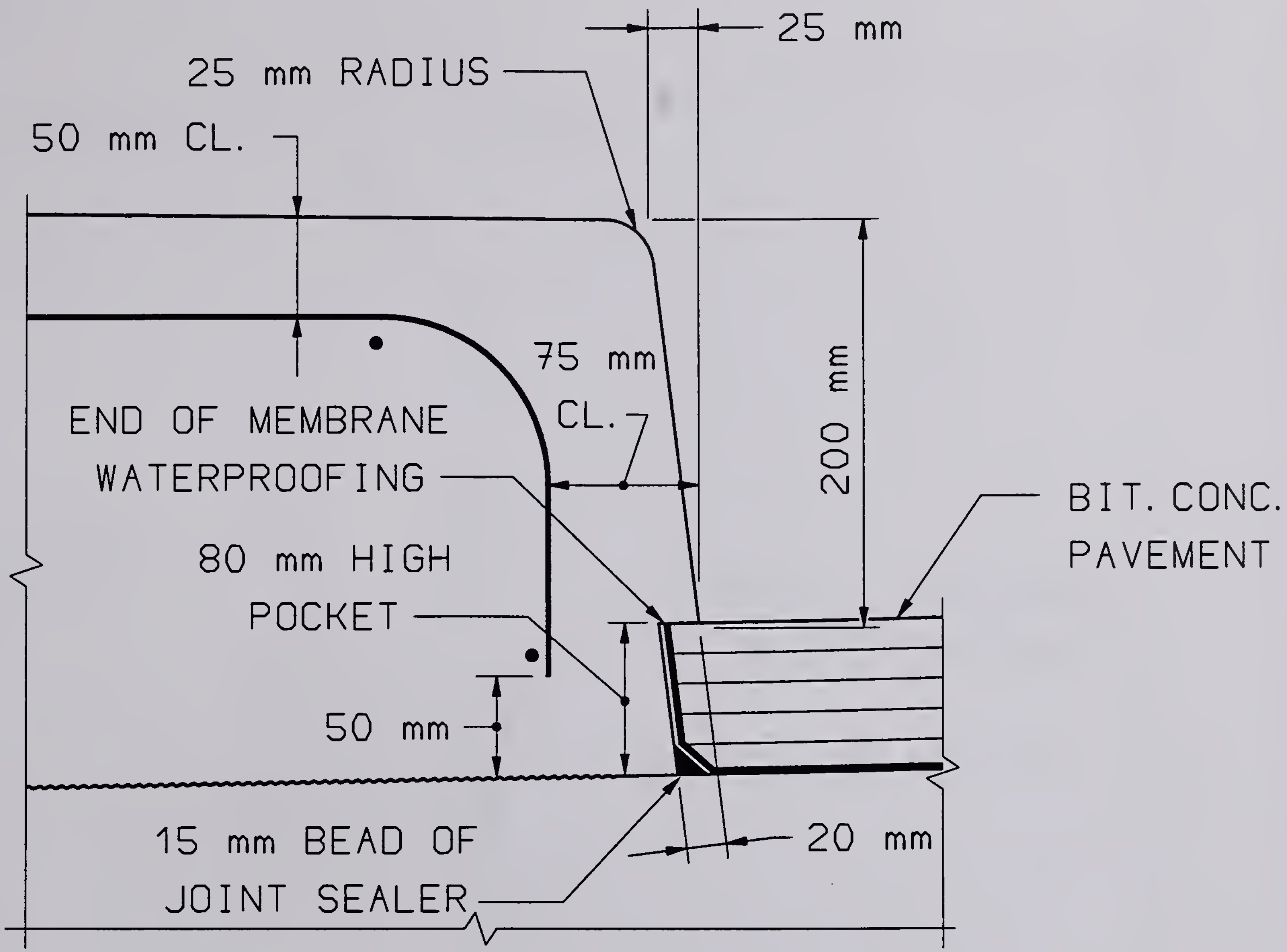
Draw to 1:10 scale min.

NOTE:

Include and label all reinforcement at the top of the wingwall.

TOP OF U-WINGWALL DETAILS

CF-PL3 BARRIER



NOTES:

1. TURN MEMBRANE UP INTO 80 mm HIGH POCKET.
2. DIMENSIONS AT THE FACE OF CURB ARE THE SAME FOR THE SAFETY CURB. *(Add this note for bridges with metal bridge rail only.)*

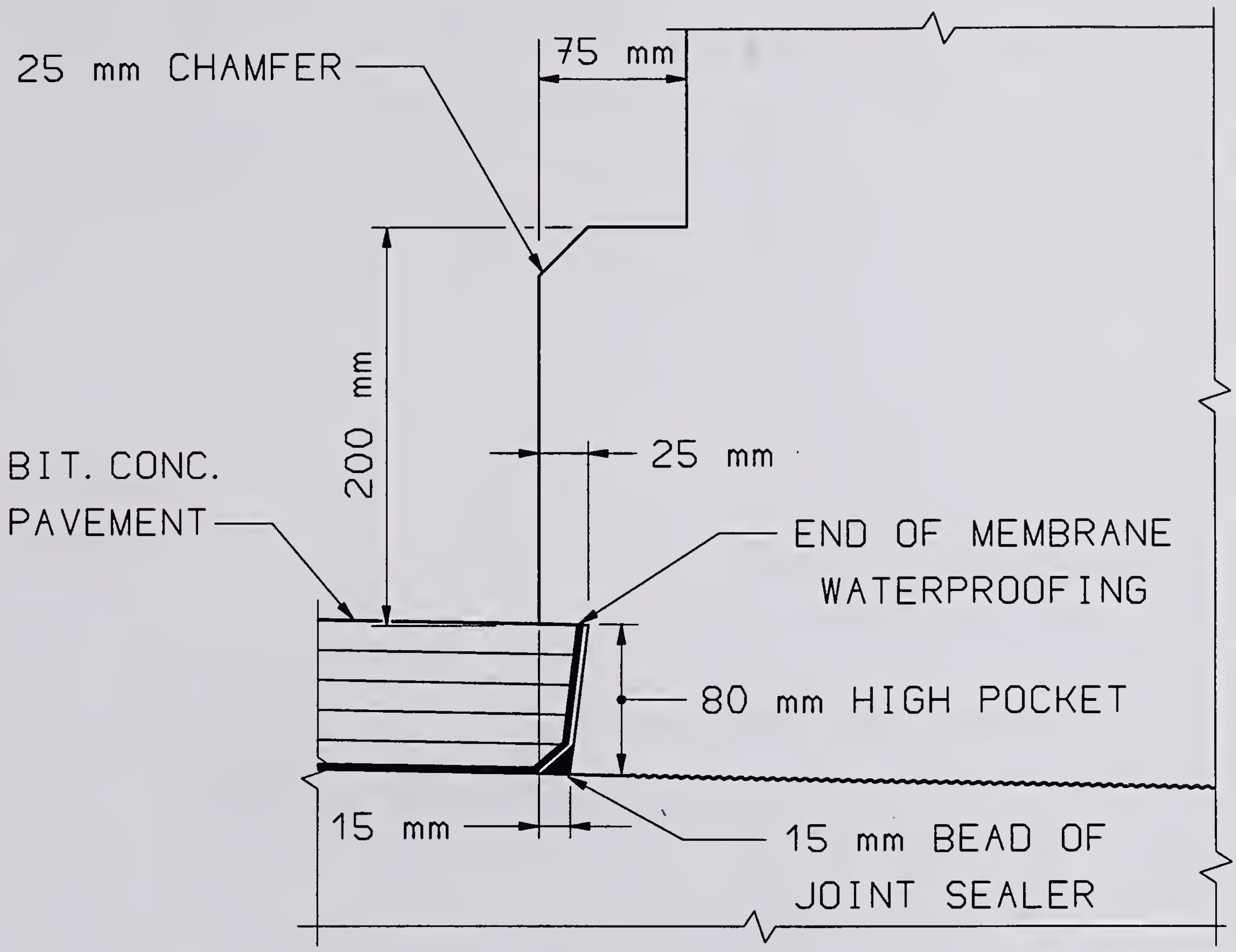
FACE OF SIDEWALK CURB DETAILS

NOT TO SCALE

NOTE:

For L.M.C. overlay, change height of pocket to 40 mm and eliminate membrane waterproofing and joint sealer. For bridges with a variable depth L.M.C. or bit. conc. surface, omit the height of pocket on drawing.

MASSHIGHWAY BRIDGE MANUAL	SIDEWALK CURB DETAILS CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.7.1**



NOTE:

TURN MEMBRANE UP INTO 80 mm HIGH POCKET.

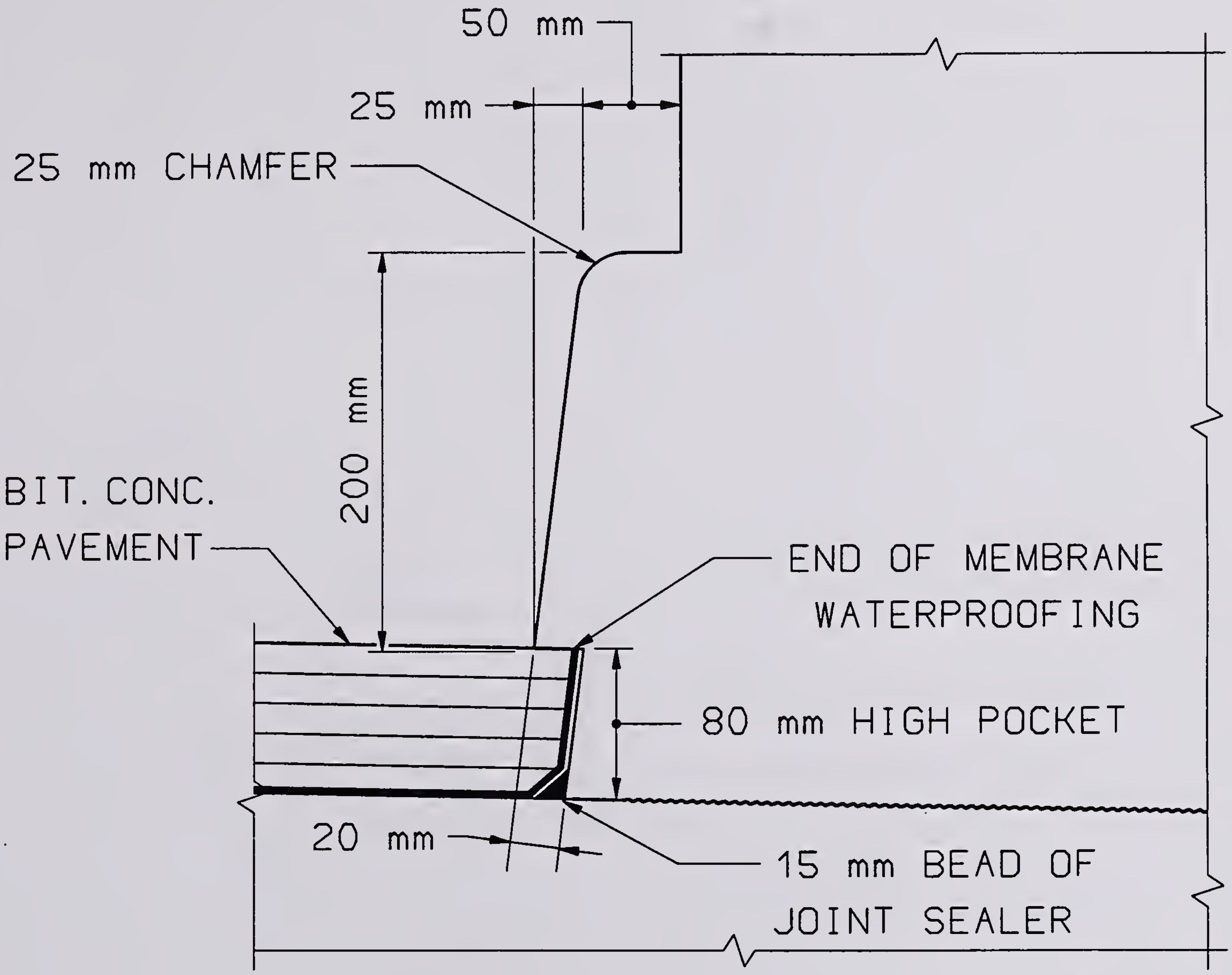
FACE OF SAFETY CURB DETAILS

NOT TO SCALE

NOTE:

For L.M.C. overlay, change height of pocket to 40 mm and eliminate membrane waterproofing and joint sealer. For bridges with a variable depth L.M.C. or bit. conc. surface, omit the height of pocket on drawing.

MASS HIGHWAY BRIDGE MANUAL	FACE OF SAFETY CURB DETAILS FOR CT-PL1* RAIL CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.7.2**



NOTE:

TURN MEMBRANE UP INTO 80 mm HIGH POCKET.

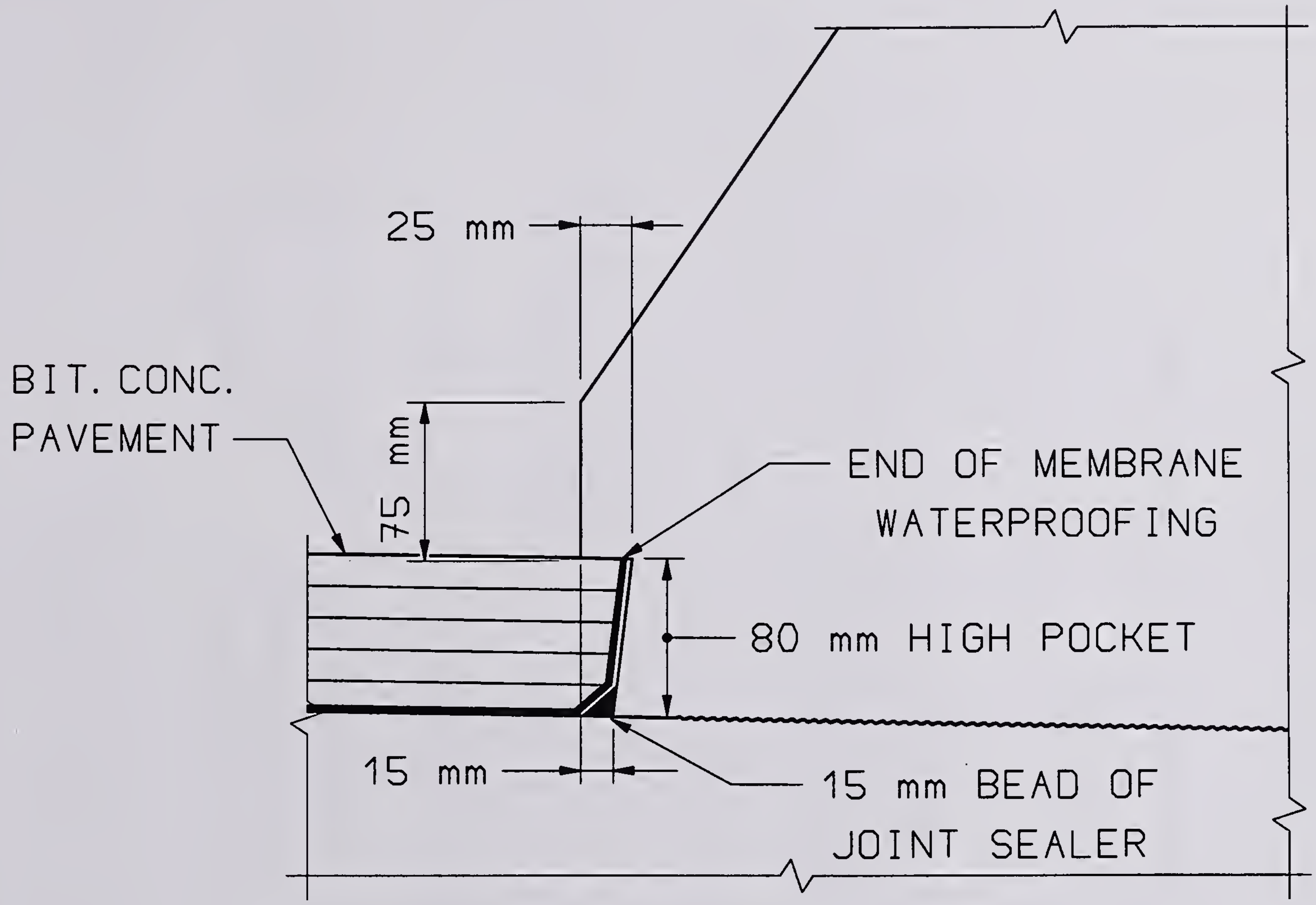
FACE OF SAFETY CURB DETAILS

NOT TO SCALE

NOTE:

For L.M.C. overlay, change height of pocket to 40 mm and eliminate membrane waterproofing and joint sealer. For bridges with a variable depth L.M.C. or bit. conc. surface, omit the height of pocket on drawing.

MASS HIGHWAY BRIDGE MANUAL	FACE OF SAFETY CURB DETAILS FOR CP-PL2 BARRIER CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.7.3**



NOTE:

TURN MEMBRANE UP INTO 80 mm HIGH POCKET.

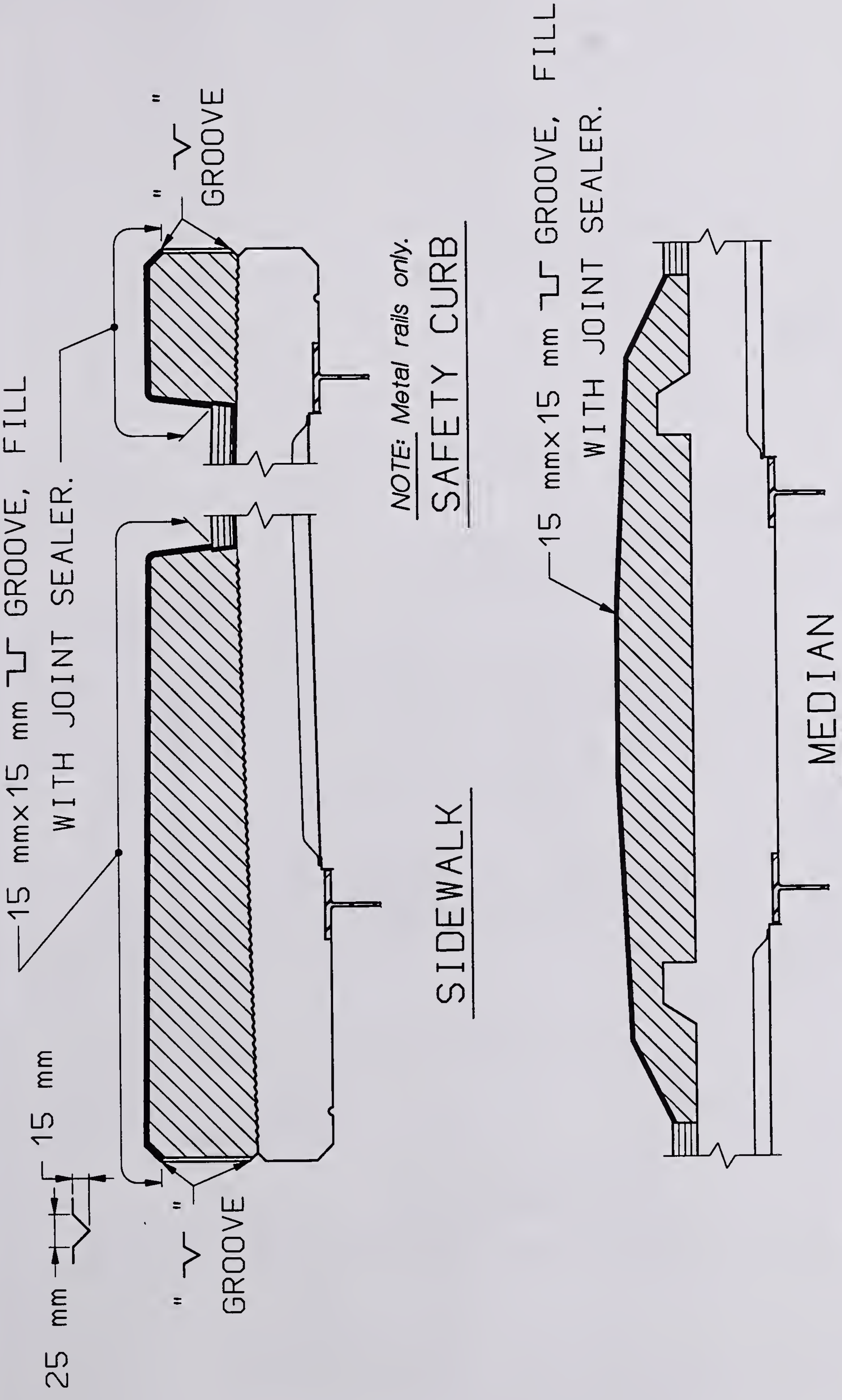
FACE OF SAFETY CURB DETAILS

NOT TO SCALE

NOTE:

For L.M.C. overlay, change height of pocket to 40 mm and eliminate membrane waterproofing and joint sealer. For bridges with a variable depth L.M.C. or bit. conc. surface, omit the height of pocket on drawing.

MASS HIGHWAY BRIDGE MANUAL	FACE OF SAFETY CURB DETAILS FOR CF BARRIERS CURB DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.7.4**

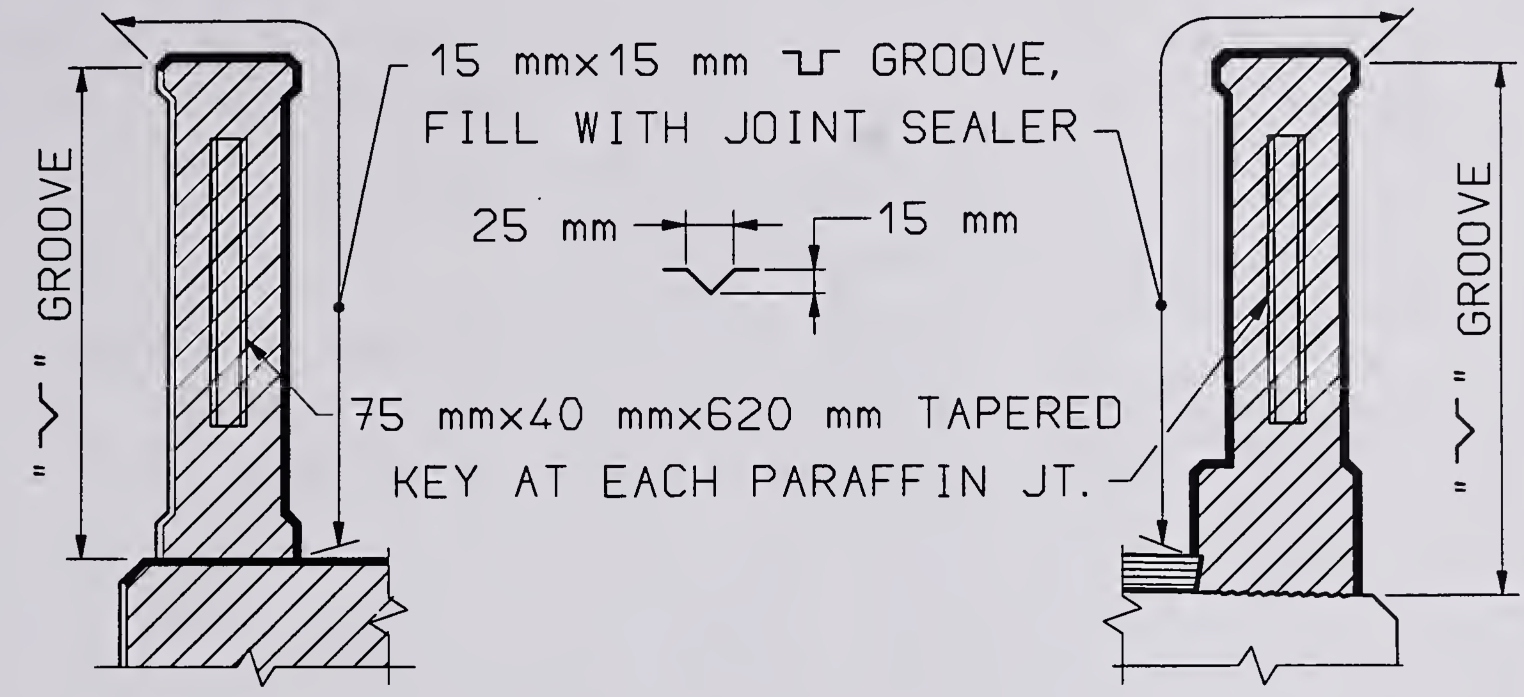

15 mm×15 mm ⅂⅃ GROOVE, FILL WITH JOINT SEALER.
25 mm
15 mm
" ⌵ " GROOVE
" ⌵ " GROOVE
SIDEWALK
NOTE: Metal rails only.
SAFETY CURB
15 mm×15 mm ⅂⅃ GROOVE, FILL WITH JOINT SEALER.
MEDIAN

NOTES: *(See Dwg. 9.8.3 for notes to appear on Construction Plans.)*

PARAFFIN JOINT DETAILS

SCALE 1:20

MASS HIGHWAY BRIDGE MANUAL	SIDEWALK, SAFETY CURB, AND MEDIAN SLABS PARAFFIN JOINT DETAILS	DATE OF ISSUE DECEMBER, 1995
		DRAWING NUMBER **9.8.1**

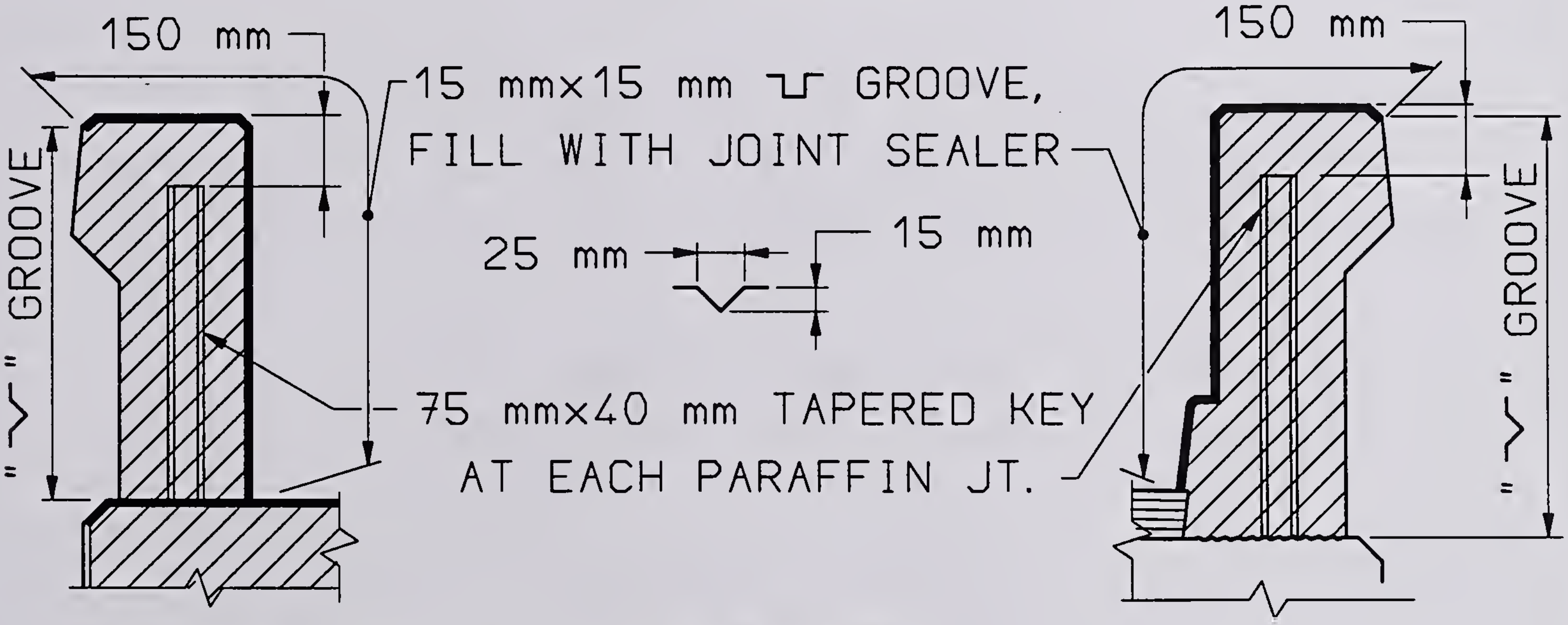


NOTE: *See Dwg. 9.8.1 for sidewalk details.*

SIDEWALK SIDE

SAFETY CURB SIDE

CT-PL1✱ RAIL



NOTE: *See Dwg. No. 9.8.1 for sidewalk details.*

SIDEWALK SIDE

SAFETY CURB SIDE

CP-PL2 BARRIER

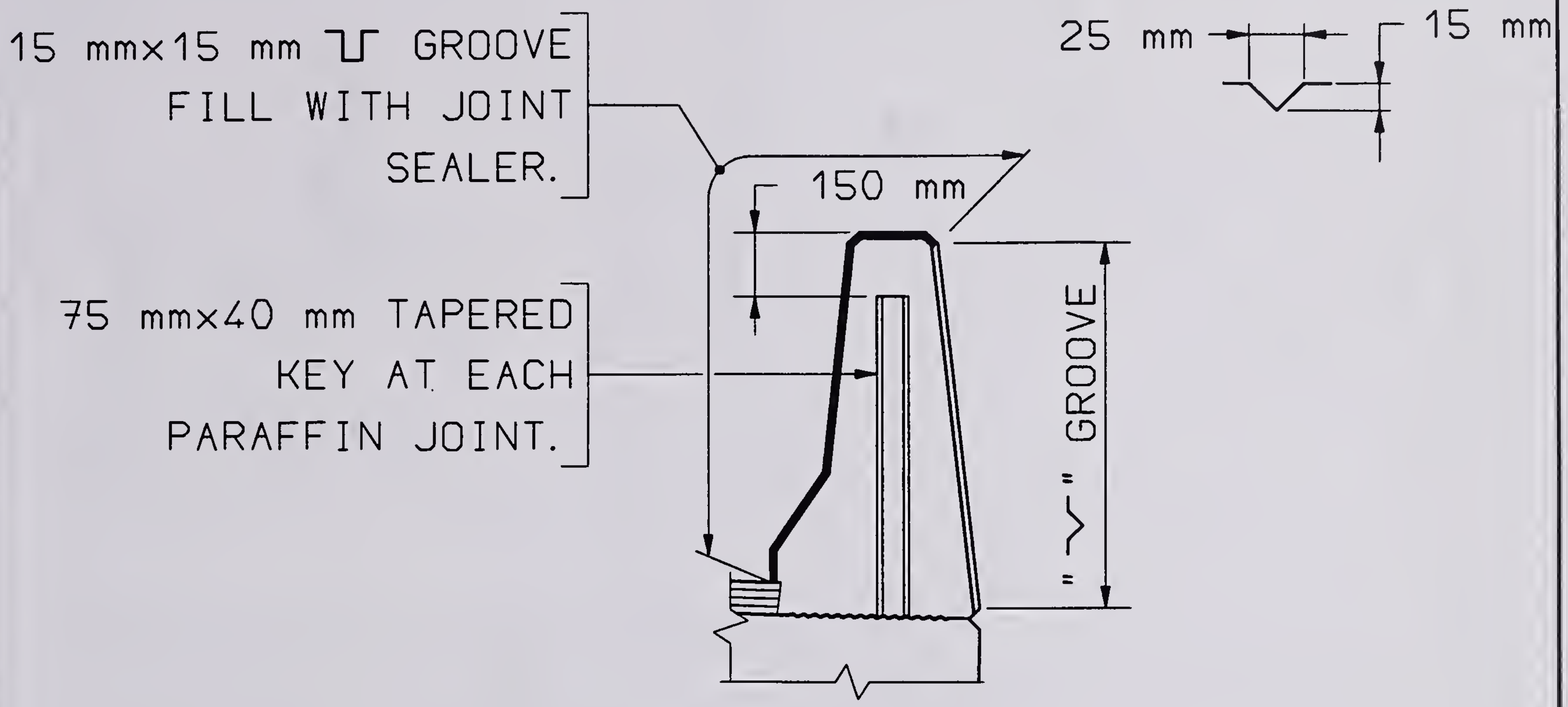
NOTES: *(See Dwg. 9.8.3 for notes to appear on construction plans)*

PARAFFIN JOINT DETAILS

SCALE 1:20

CT-PL1✱ RAIL AND
CP-PL2 BARRIER
PARAFFIN JOINT DETAILS

DATE OF ISSUE
DECEMBER, 1995


15 mm×15 mm ⊔ GROOVE FILL WITH JOINT SEALER.
75 mm×40 mm TAPERED KEY AT EACH PARAFFIN JOINT.
150 mm
25 mm
15 mm
"V" GROOVE

CF BARRIERS

NOTES:

1. ALL CONCRETE CONSTRUCTION ABOVE SLAB SHALL BE POURED IN ALTERNATE SECTIONS AND SHALL HAVE A CURING PERIOD OF NOT LESS THAN 3 DAYS BETWEEN POURS.
2. DO NOT CARRY LONGITUDINAL BARS THROUGH THE PARAFFIN JOINTS. END THE REINFORCEMENT 50 mm CLEAR OF JOINT.
3. JOINT SHALL BE SQUARE TO FACE OF CURB *(or coping)*.

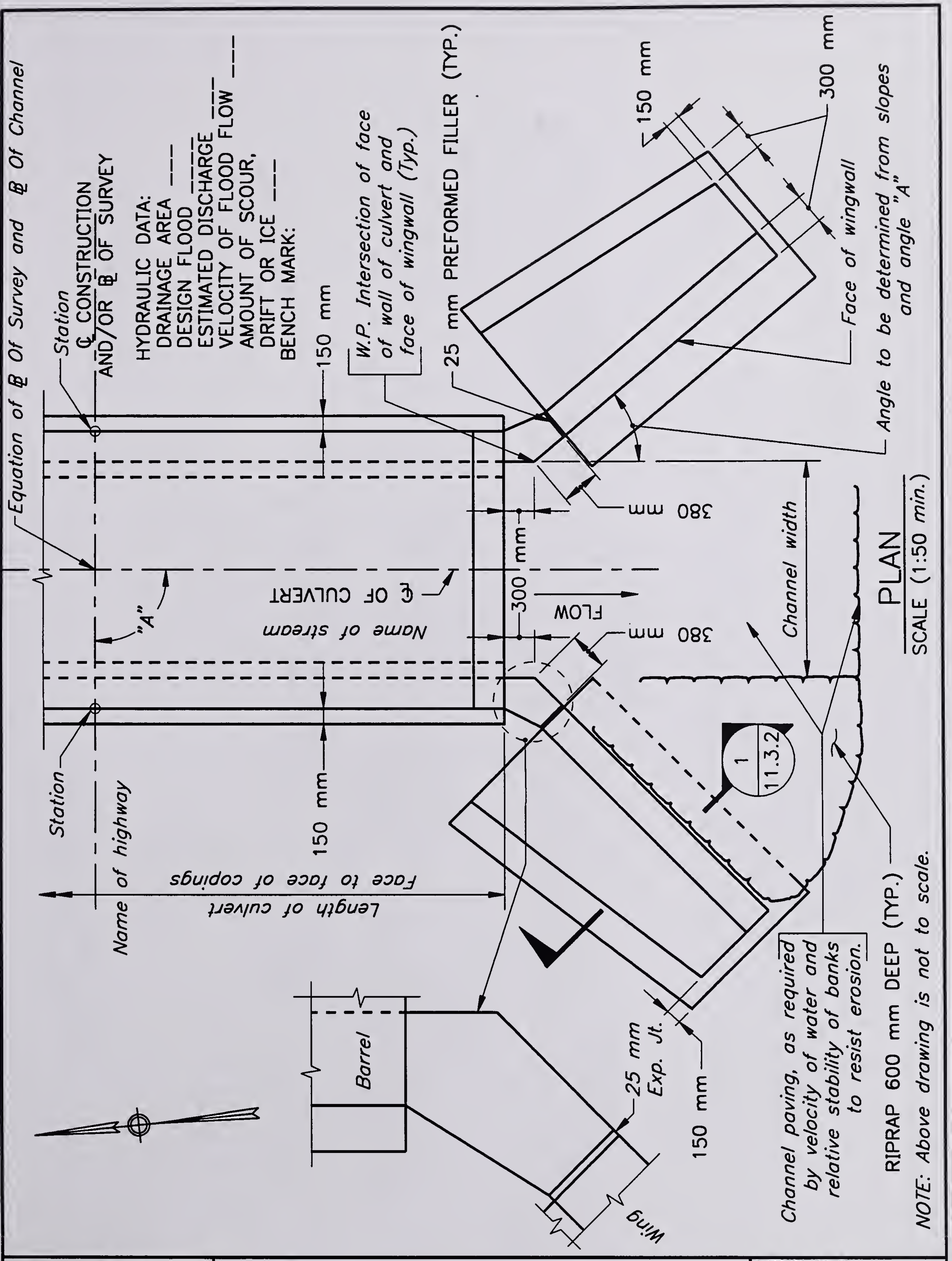
PARAFFIN JOINT DETAILS

SCALE 1:20

NOTES:

1. *Modify the details shown in this section as required to show the correct shape, wearing surface, and support beams.*
2. *Paraffin joints for sidewalk and safety curb slabs for metal railing shall be located at the approximate center of every third railing panel. Paraffin joints for concrete railing or barriers shall be spaced preferrably between 6 m and 7.5 m, a minimum of 4.5 m may be used if necessary. The location of the joints shall be dimensioned on the construction plans.*
3. *Note on plans that the bent plate edging shall not be continuous through paraffin joints.*

MASS HIGHWAY BRIDGE MANUAL	CF BARRIERS AND NOTES PARAFFIN JOINT DETAILS	DATE OF ISSUE DECEMBER, 1995 DRAWING NUMBER **9.8.3**



Plot Scale = 1:50

MASS HIGHWAY
BRIDGE MANUAL

TYPICAL PLAN VIEW
ROADWAY OVER FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.1.1

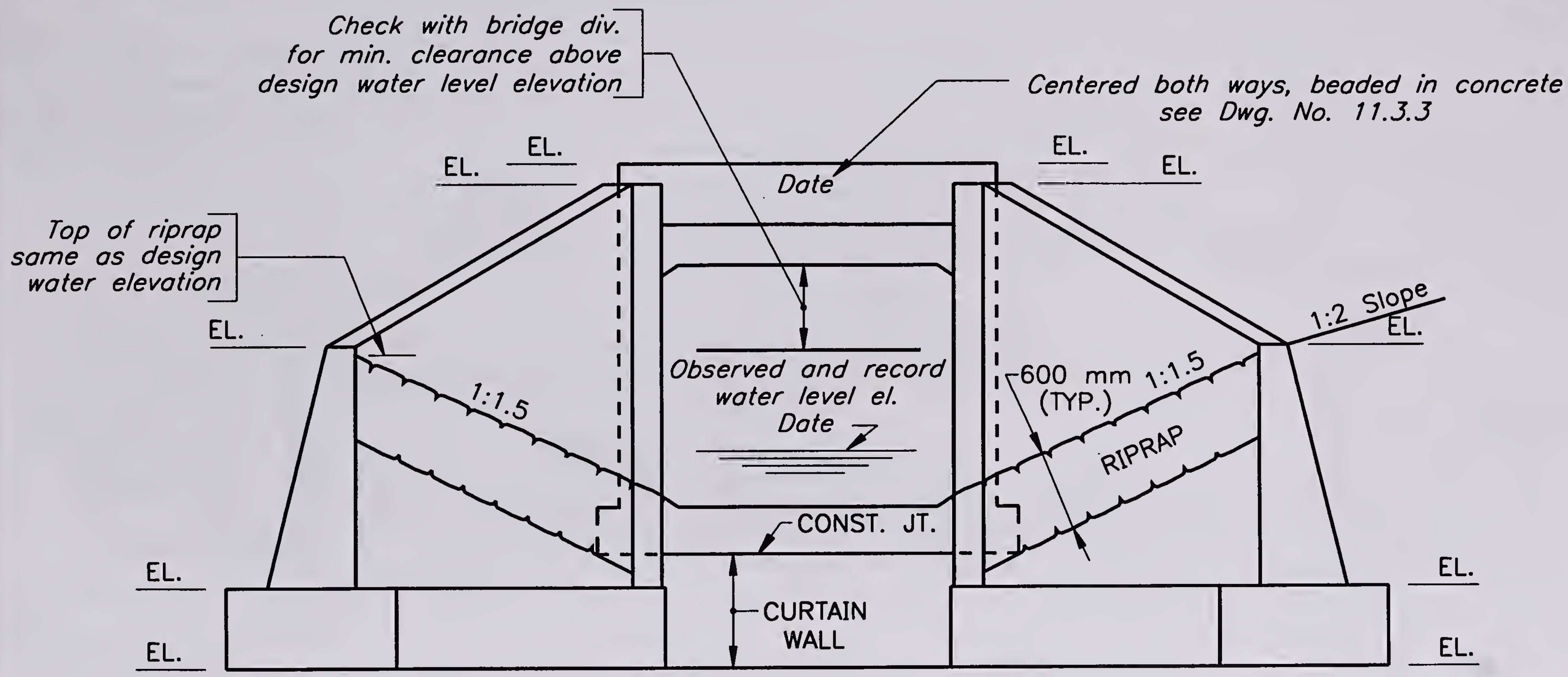
Plot Scale = 1:50

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL ELEVATION VIEW
ROADWAY OVER FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.1.2



Check with bridge div. for min. clearance above design water level elevation

Centered both ways, beaded in concrete see Dwg. No. 11.3.3

Top of riprap same as design water elevation

NOTE:
Show approx. existing ground

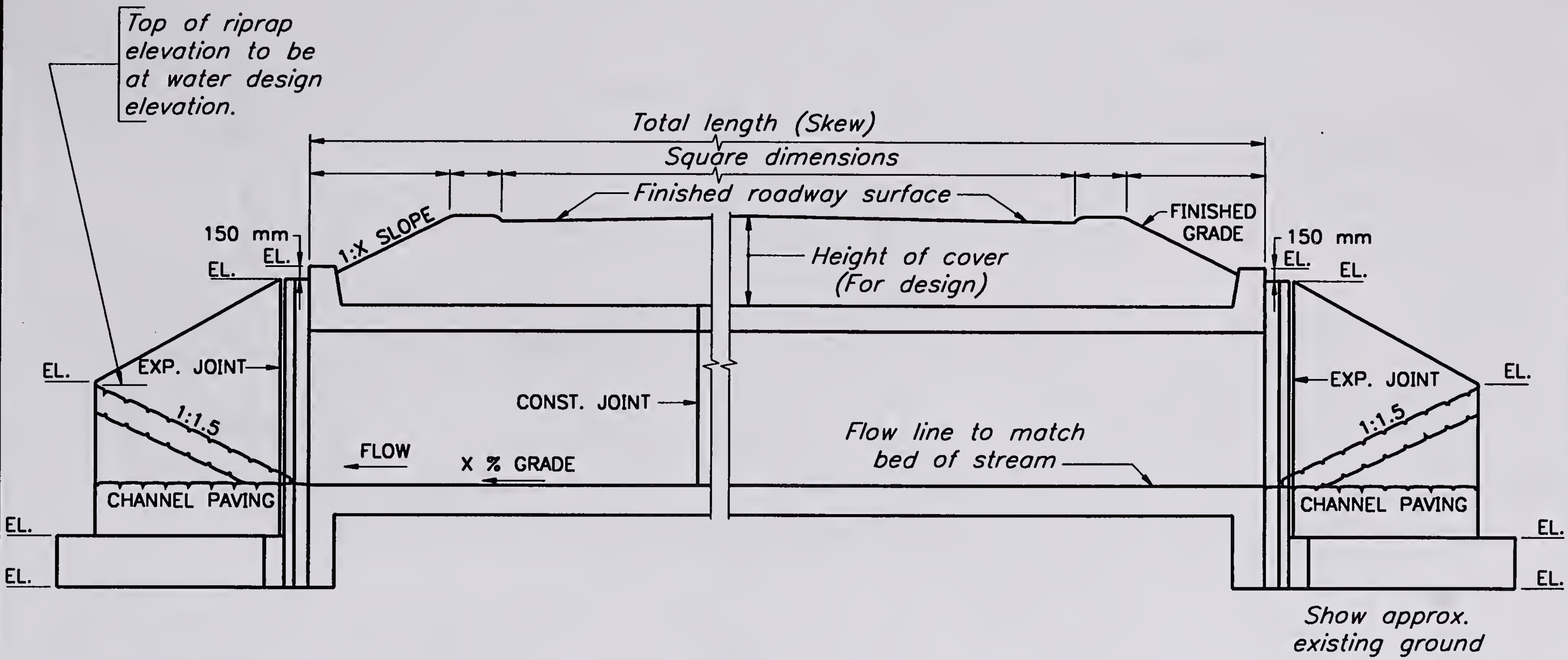
Bottom of footing should not be less than 1.2 m below bed of stream.

ELEVATION
SCALE (1:50 *min.*)

NOTES:

1. Contract plans will be prepared incorporating the design features shown in these standards.
2. Borings: At least two borings will be taken for each culvert.
   A boring plan will be prepared in accordance with bridge division standards.
3. Show typical channel cross section.
4. Note on sketch plans and contract plans design loading used.
5. Ends of culverts to be parallel to ℄ of construction up to 3 m of cover. Where height of cover is 3 m or more, ends of culverts are to be square regardless of skew of culvert.
6. Above drawing is not to scale.

Plot Scale = 1:75



LONGITUDINAL SECTION

SCALE (1:50 min.)

NOTES:

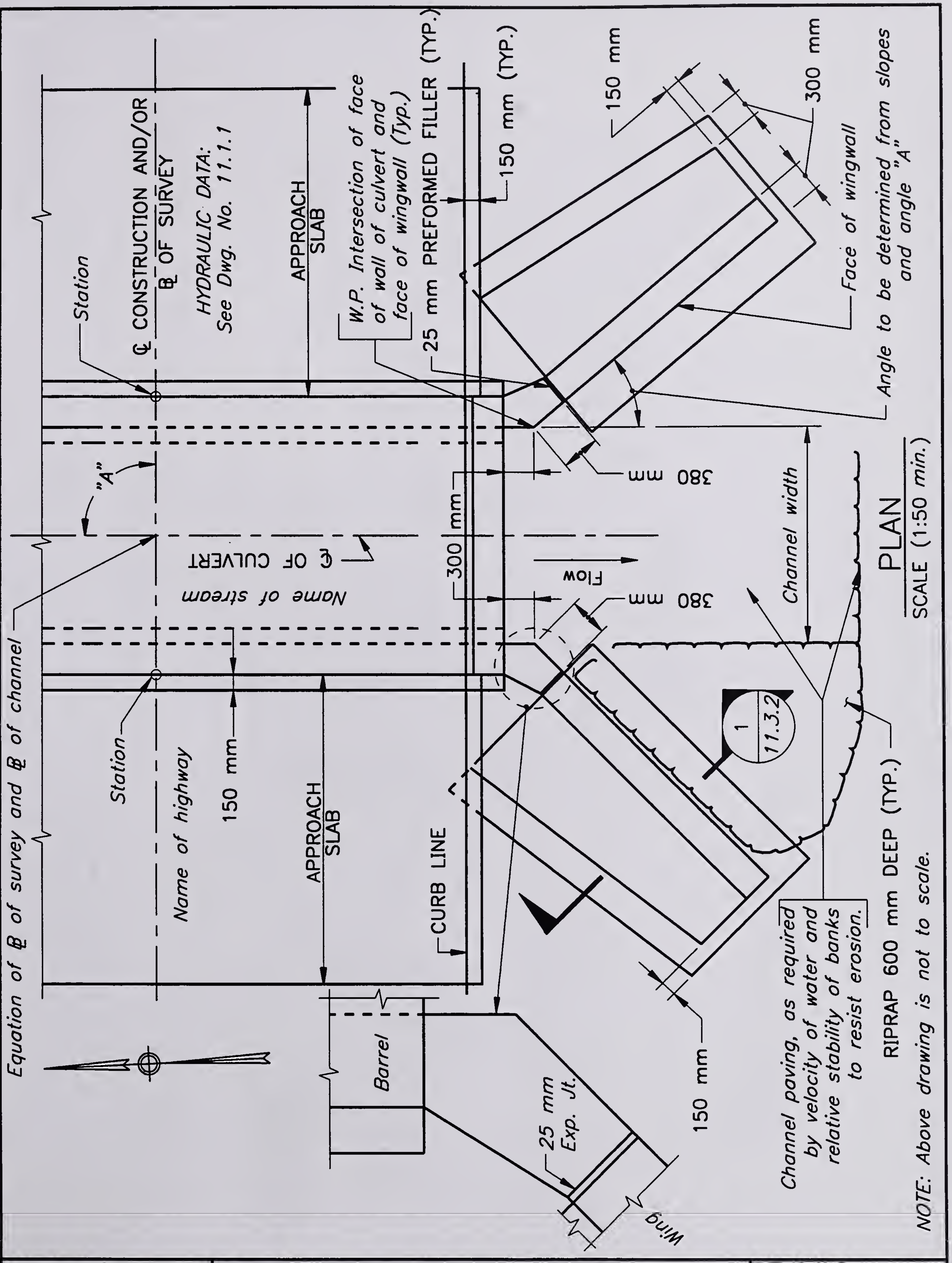
1. *Expansion joints 27 m O.C., maximum.*
2. *Construction joints 9 m O.C., maximum.*
3. *Above drawing is not to scale.*

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL LONGITUDINAL SECTION
ROADWAY OVER FILL

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.1.3


Station
℄ CONSTRUCTION AND/OR
℞ OF SURVEY
HYDRAULIC DATA:
See Dwg. No. 11.1.1
APPROACH SLAB
W.P. Intersection of face of wall of culvert and face of wingwall (Typ.)
25 mm PREFORMED FILLER (TYP.)
150 mm (TYP.)
150 mm
300 mm
Face of wingwall
Angle to be determined from slopes and angle "A"
"A"
℄ OF CULVERT
Name of stream
380 mm
300 mm
380 mm
Flow
Channel width
PLAN
SCALE (1:50 min.)
Equation of ℞ of survey and ℞ of channel
Station
Name of highway
150 mm
APPROACH SLAB
CURB LINE
1
11.3.2
RIPRAP 600 mm DEEP (TYP.)
Channel paving, as required by velocity of water and relative stability of banks to resist erosion.
150 mm
Barrel
25 mm Exp. Jt.
Wing
NOTE: Above drawing is not to scale.

Plot Scale = 1:50

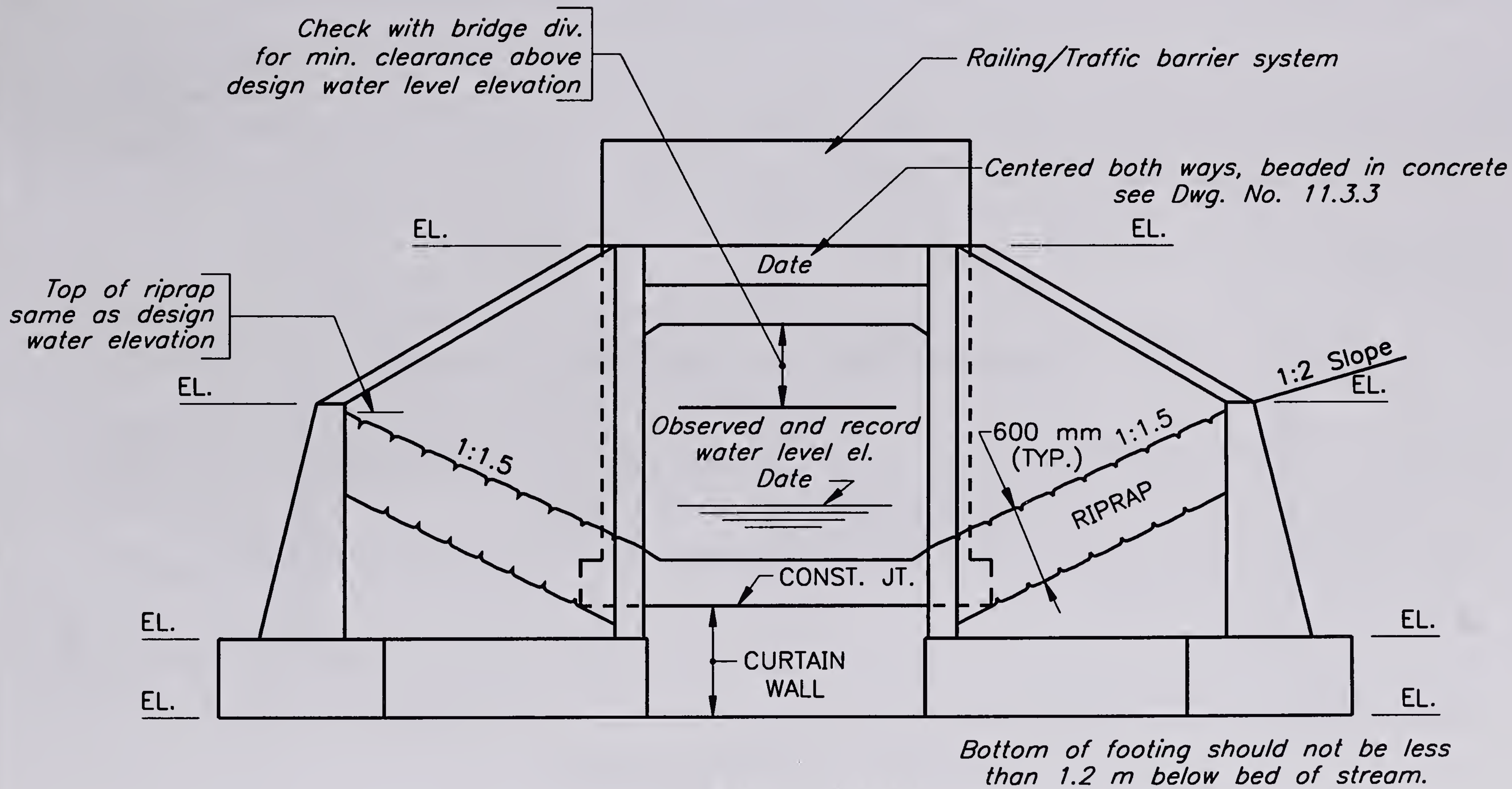
MASS HIGHWAY
BRIDGE MANUAL

TYPICAL PLAN VIEW
ROADWAY ON BARREL ROOF

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.2.1

Plot Scale = 1:50


Check with bridge div. for min. clearance above design water level elevation
Railing/Traffic barrier system
Centered both ways, beaded in concrete see Dwg. No. 11.3.3
EL.
EL.
Date
Top of riprap same as design water elevation
EL.
1:2 Slope
EL.
Observed and record water level el. Date
600 mm (TYP.)
1:1.5
1:1.5
RIPRAP
CONST. JT.
EL.
EL.
CURTAIN WALL
EL.
EL.
Bottom of footing should not be less than 1.2 m below bed of stream.

ELEVATION

SCALE 1:50 *(min.)*

NOTE:
Show approx. existing ground

NOTES:
1. *Above drawing is not to scale.*
2. *See notes on Dwg. No. 11.1.2.*

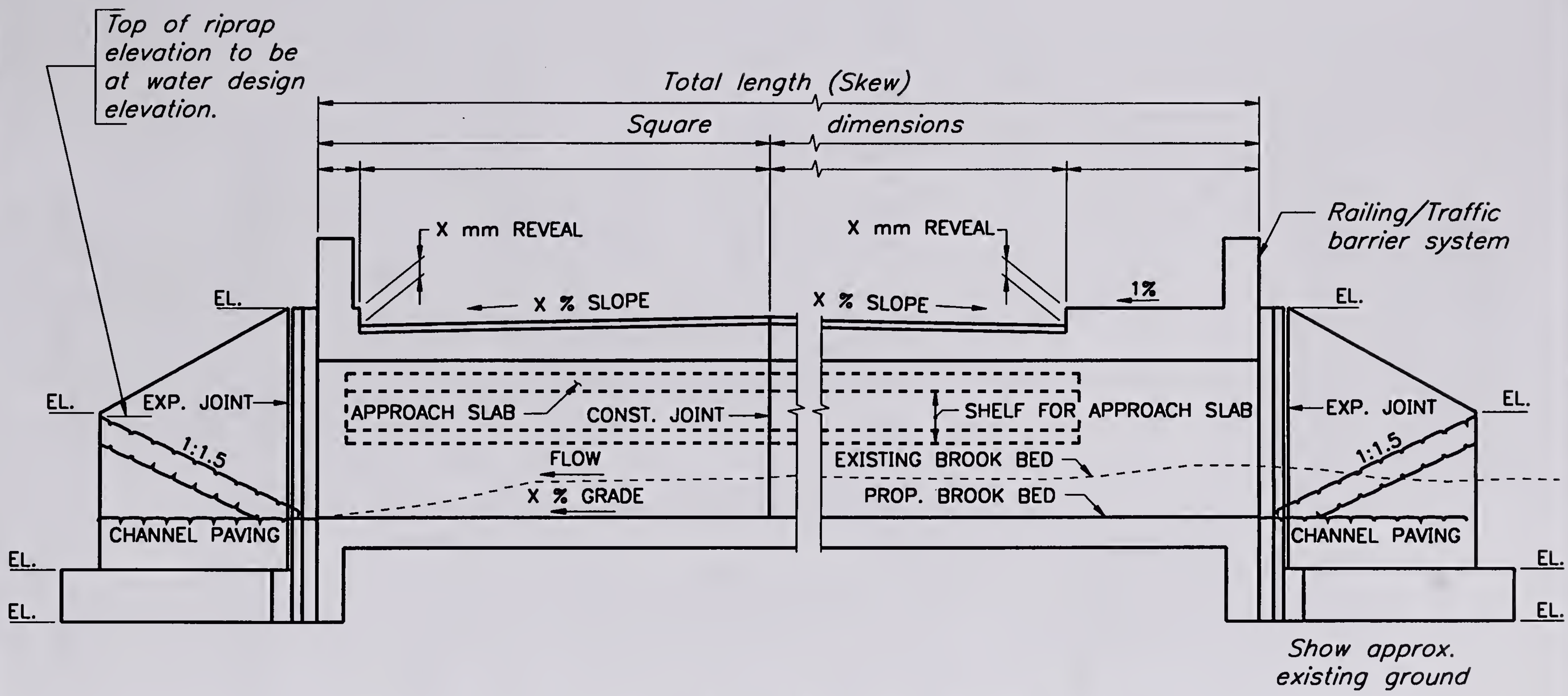
MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL ELEVATION VIEW
ROADWAY ON BARREL ROOF

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.2.2

Plot Scale = 1:75



LONGITUDINAL SECTION

SCALE (1:50 *min.*)

NOTES:

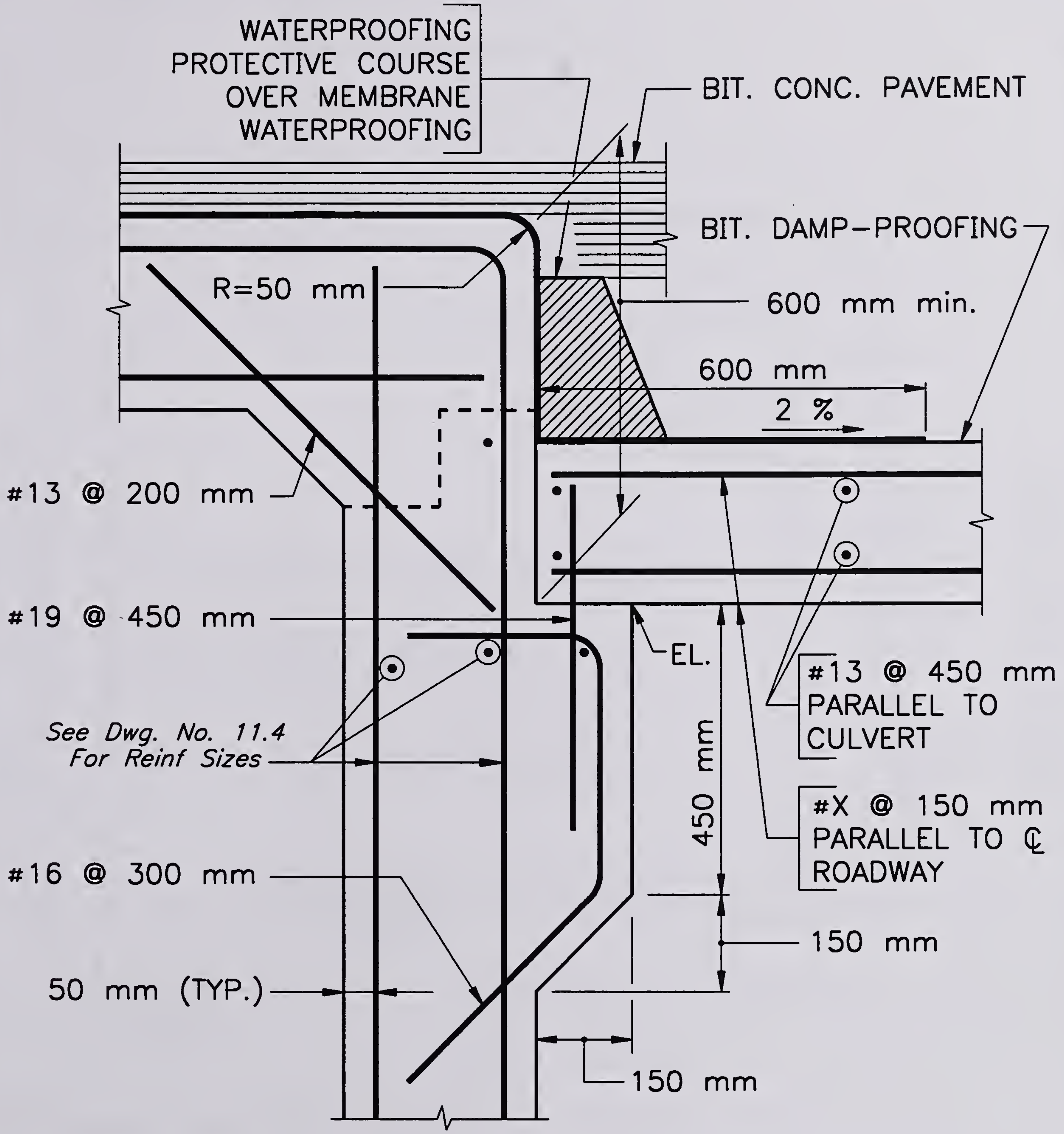
1. *Expansion joints 27 m O.C., maximum.*
   Construction joints 9 m O.C., maximum.
2. *Above drawing is not to scale.*

MASSHIGHWAY
BRIDGE
MANUAL

TYPICAL LONGITUDINAL SECTION
ROADWAY ON BARREL ROOF

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.2.3


WATERPROOFING PROTECTIVE COURSE OVER MEMBRANE WATERPROOFING
BIT. CONC. PAVEMENT
BIT. DAMP-PROOFING
R=50 mm
600 mm min.
600 mm
2 %
#13 @ 200 mm
#19 @ 450 mm
EL.
#13 @ 450 mm PARALLEL TO CULVERT
See Dwg. No. 11.4 For Reinf Sizes
#X @ 150 mm PARALLEL TO ℄ ROADWAY
450 mm
#16 @ 300 mm
150 mm
50 mm (TYP.)
150 mm

SHELF FOR APPROACH SLAB

SCALE (1:10*min.*)

NOTE: *Above drawing is not to scale.*

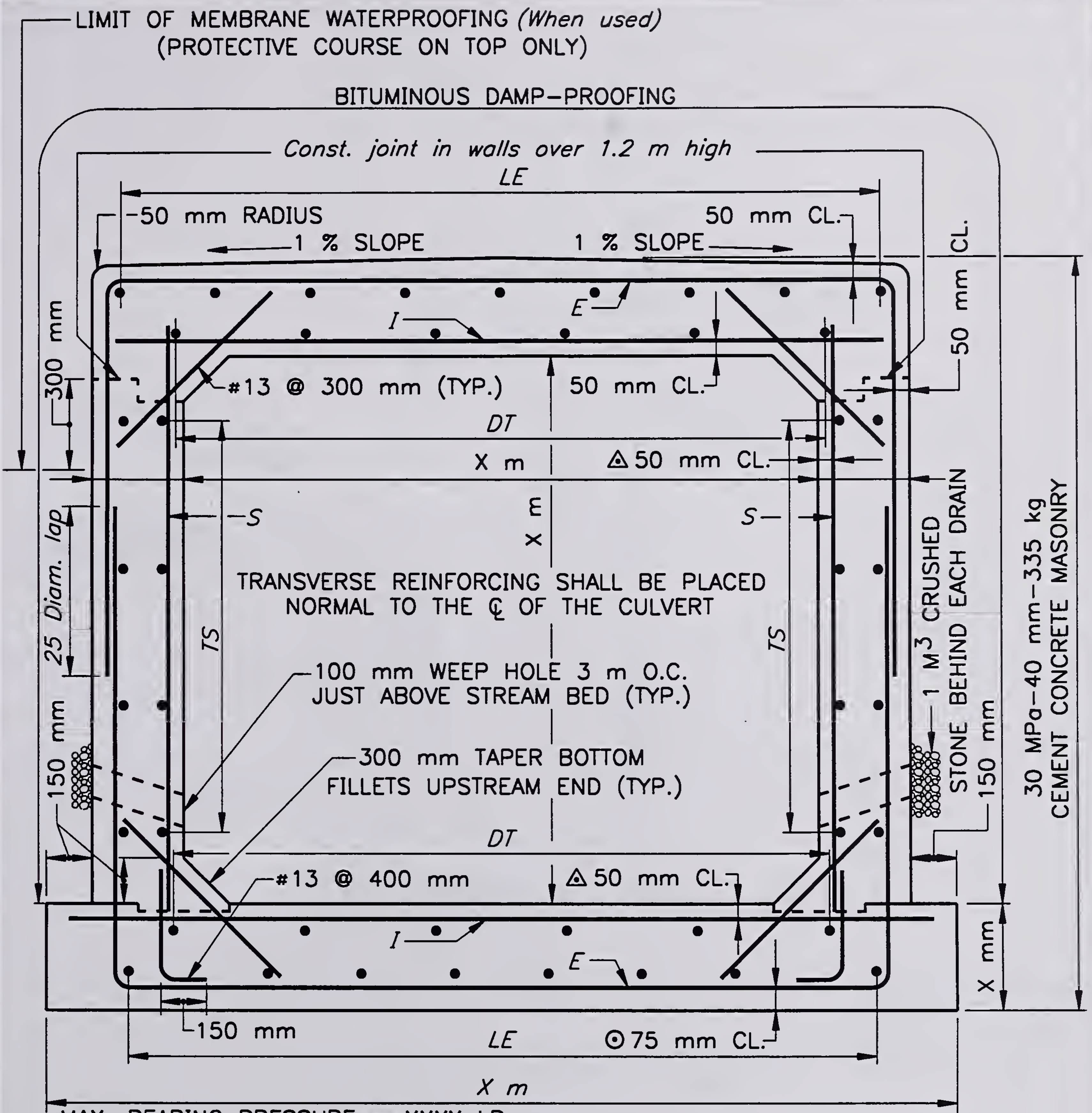
Plot Scale = 1:10

MASS HIGHWAY
BRIDGE
MANUAL

APPROACH SLAB SHELF DETAILS
ROADWAY ON BARREL ROOF

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.2.4


LIMIT OF MEMBRANE WATERPROOFING (When used)
(PROTECTIVE COURSE ON TOP ONLY)
BITUMINOUS DAMP-PROOFING
Const. joint in walls over 1.2 m high
LE
50 mm RADIUS
50 mm CL.
1 % SLOPE
1 % SLOPE
50 mm CL.
E
I
300 mm
#13 @ 300 mm (TYP.)
50 mm CL.
DT
X m
△50 mm CL.
X m
S
S
25 Diam. lap
TRANSVERSE REINFORCING SHALL BE PLACED NORMAL TO THE ℄ OF THE CULVERT
TS
TS
1 M³ CRUSHED STONE BEHIND EACH DRAIN
30 MPa-40 mm-335 kg CEMENT CONCRETE MASONRY
100 mm WEEP HOLE 3 m O.C. JUST ABOVE STREAM BED (TYP.)
300 mm TAPER BOTTOM FILLETS UPSTREAM END (TYP.)
150 mm
150 mm
DT
#13 @ 400 mm
△50 mm CL.
I
E
X mm
150 mm
LE
⊙75 mm CL.
X m

MAX. BEARING PRESSURE = XXXX kPa

SECTION THRU BARREL

SCALE (1:20 *min.*)

NOTES:

1. *Above drawing is not to scale.*
2. *Use membrane waterproofing with a waterproofing protective course where roadway pavement is directly on the structure and on all structures where the clear span is over 6.0 m. Use bituminous damp-proofing where roadway is not directly on the structure and the clear span is less than 6.0 m.*
3. *△ – Indicates 75 mm if exposed to salt water.*
   ⊙ – Indicates 100 mm if exposed to salt water.
   Thus increasing sidewalls 25 mm and bottom slab 50 mm
4. *See section 11.4 for valves of TS, S, DT, I, E, and LE.*

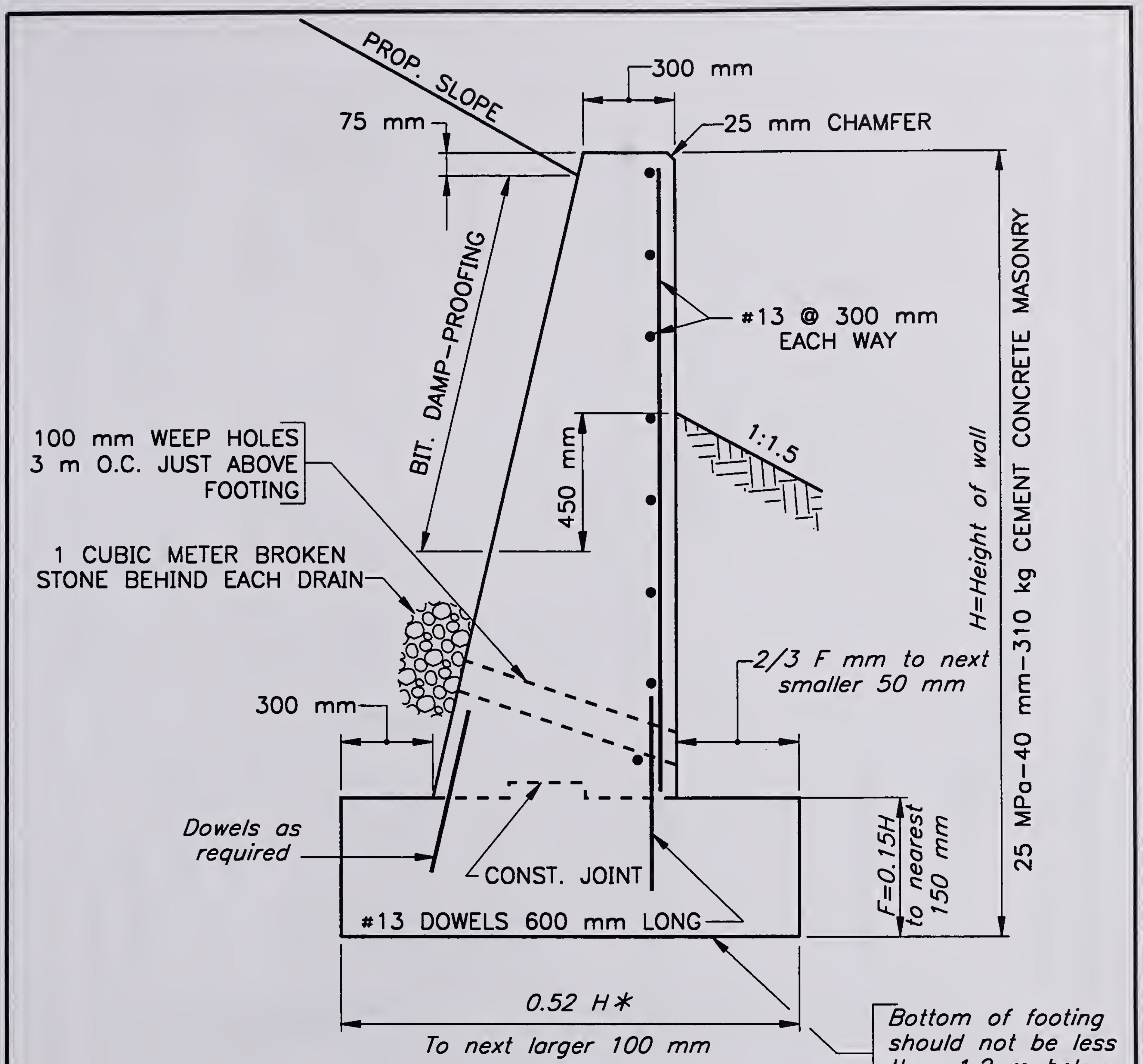
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL SECTION THRU
REINFORCED CONC. BOX CULVERT
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.3.1



MAX. BEARING PRESSURE = XXXX kPa

SECTION 1

SCALE (1:20 *min.*)

NOTES:

1. *Above drawing is not to scale.*
2. ** – Design base width including any live load surcharge and the effects of sloping backfills.*
3. *Cantilever wingwall may be used where maximum pressure of footing must be kept low because of low bearing value of subsoil.*

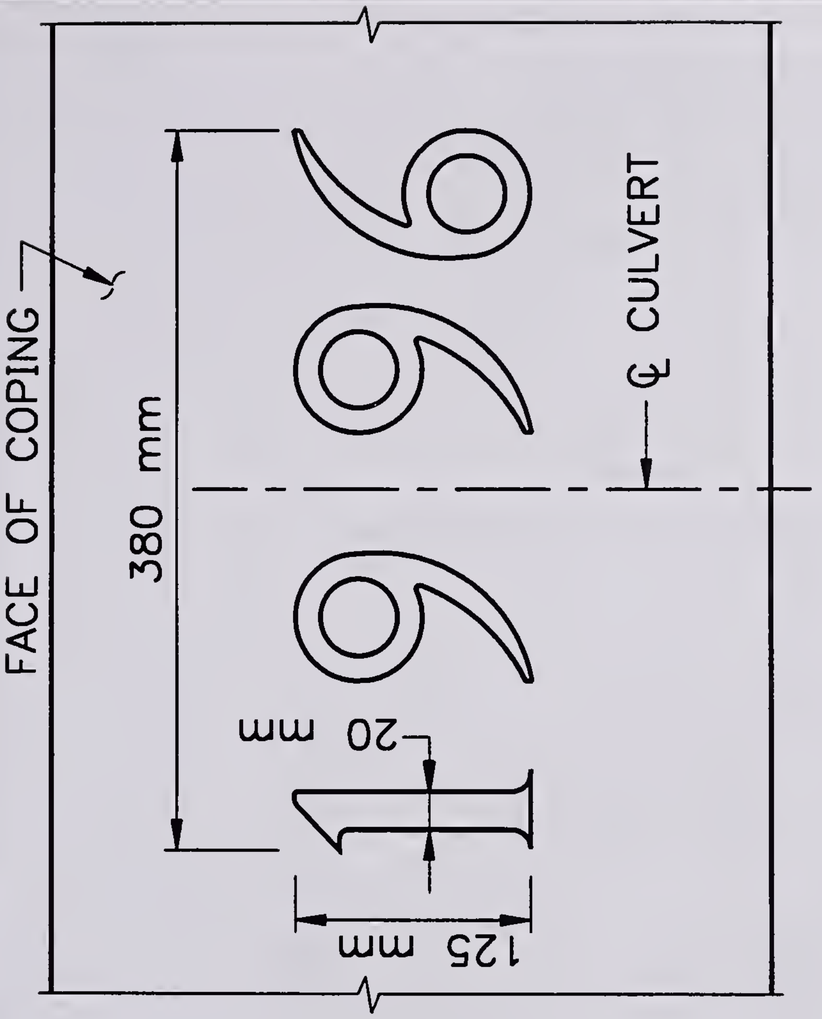
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

TYPICAL SECTION THRU
WINGWALL
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

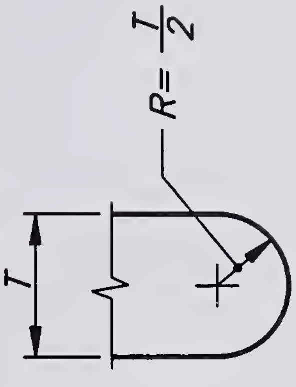
DRAWING NUMBER
11.3.2



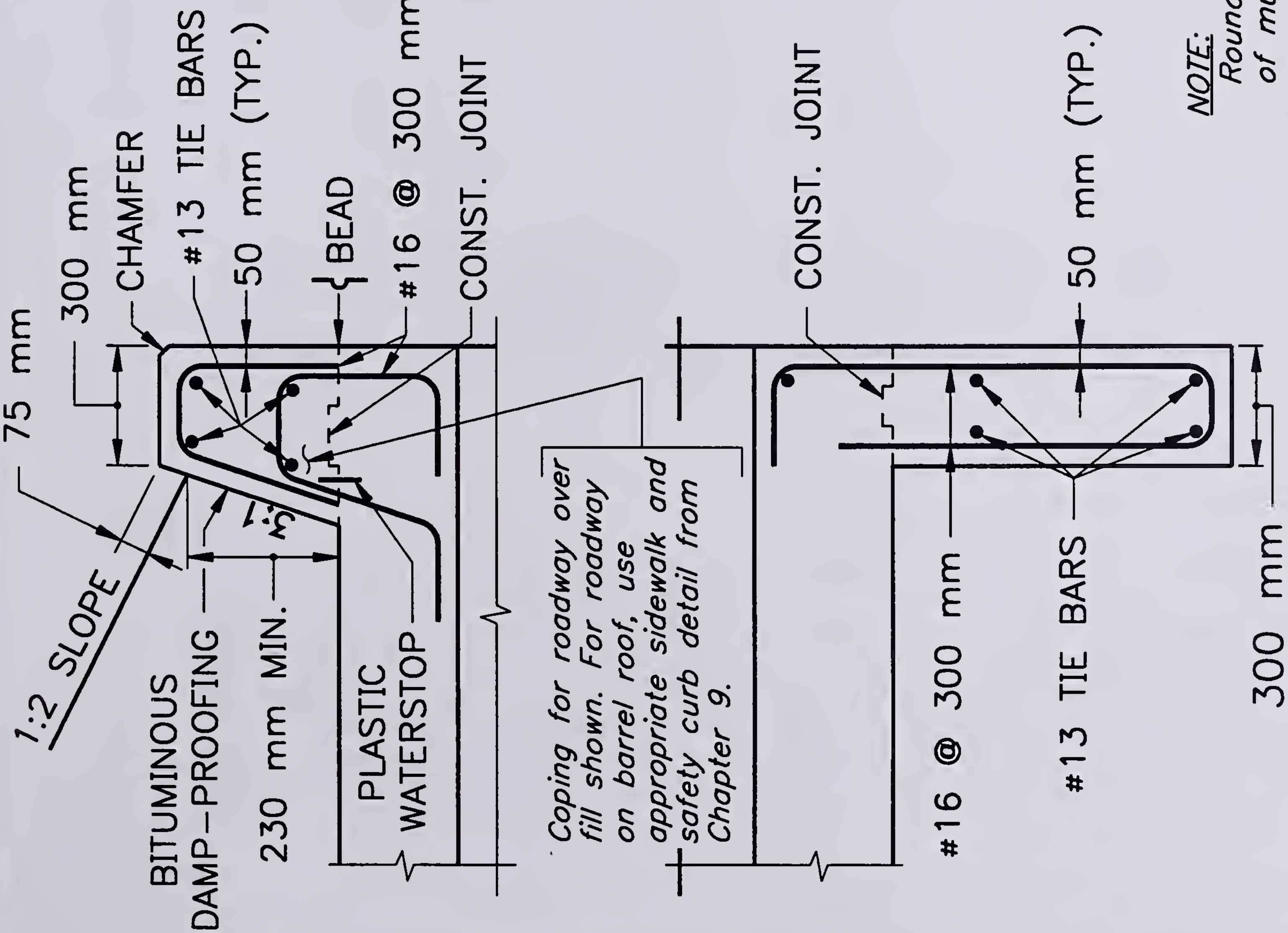
NOTE: A SHEET WILL BE FURNISHED.

DATE ON COPING

NOT TO SCALE



NOTE:
Round the ends of inside wall of multi-barreled culverts, thus.



Coping for roadway over fill shown. For roadway on barrel roof, use appropriate sidewalk and safety curb detail from Chapter 9.

DETAIL AT CULVERT ENDS

SCALE (1:20 min.)

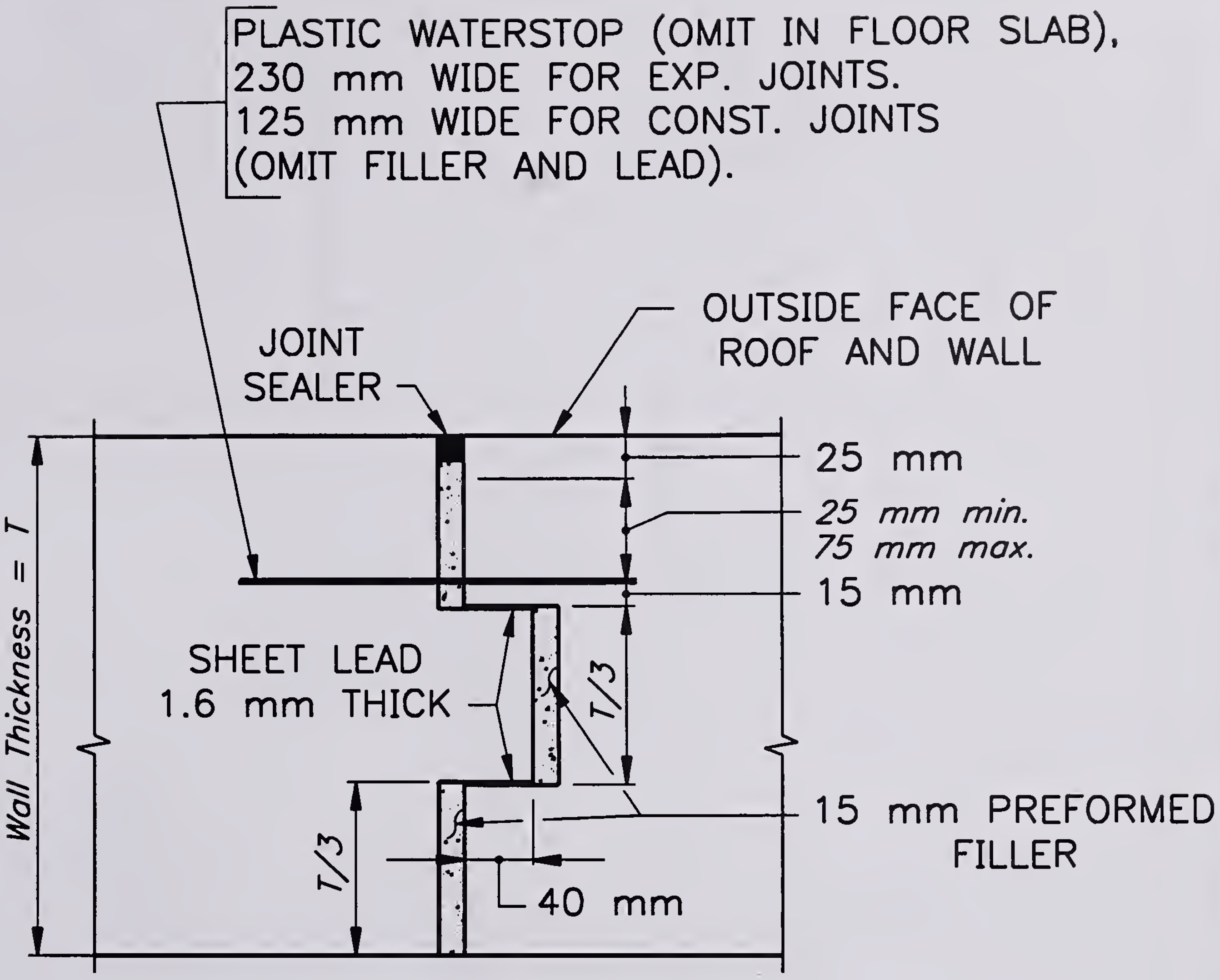
Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

DETAILS AT FACE OF CULVERT
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.3.3



EXPANSION AND CONSTRUCTION JOINT DETAILS

NOT TO SCALE

NOTES:

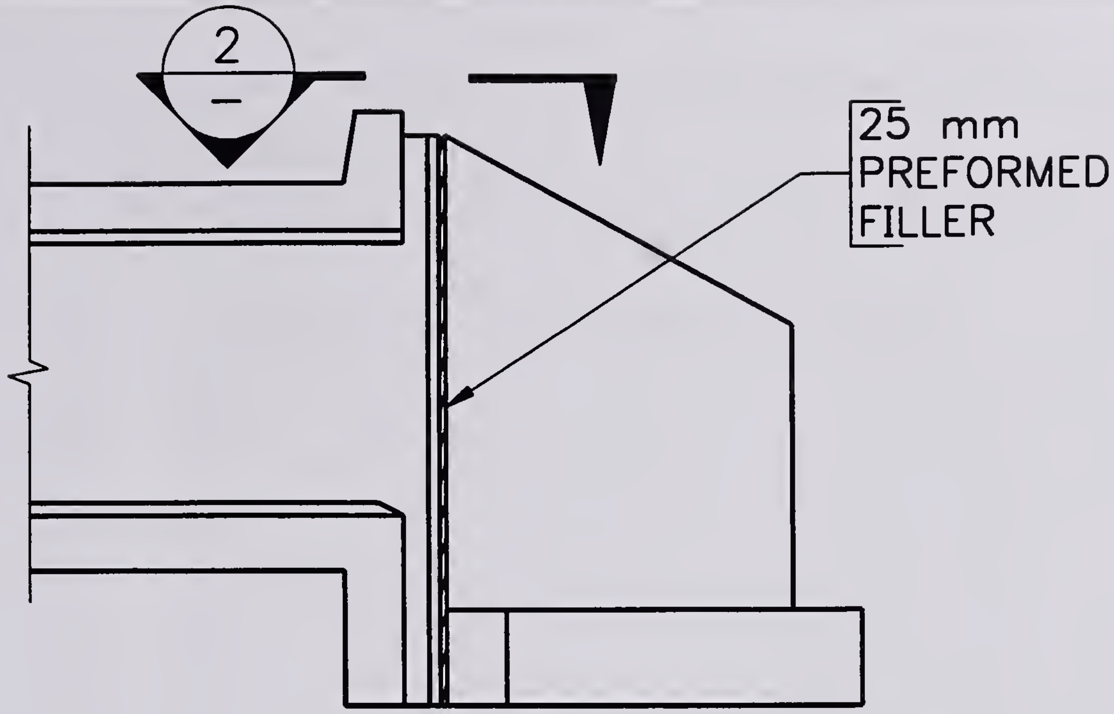
1. *Where culvert is more than 60 m in length, exp. and const. joints are to be carried into floor of culvert.*
2. *Where culvert is more than 30 m in length with roadway embankment more than 3 m (Measured from roof to roadway surface) and the foundation support is gravel borrow for bridge foundations, exp. and const. joints are to be carried into floor of culvert.*
3. *In all others cases, expansion joints are at 27 m ± and construction joints at 9 m ± and are omitted in the floor of culvert.*

Plot Scale = 1:5

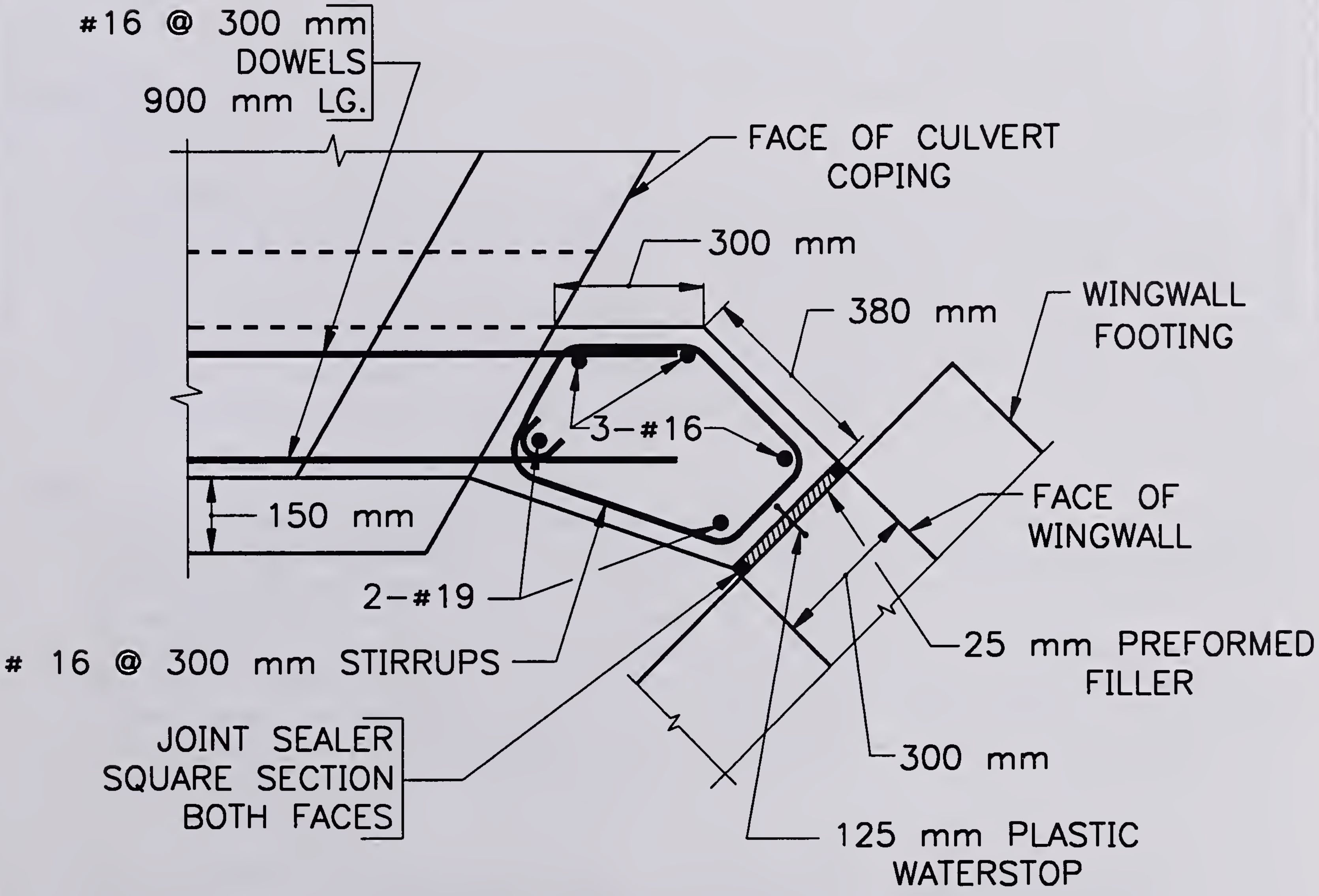
EXPANSION AND CONSTRUCTION
JOINT DETAILS
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.3.4



ELEVATION
NOT TO SCALE



SECTION 2
SCALE (1:10 min.)

CULVERT JOINT DETAIL AT WINGWALL

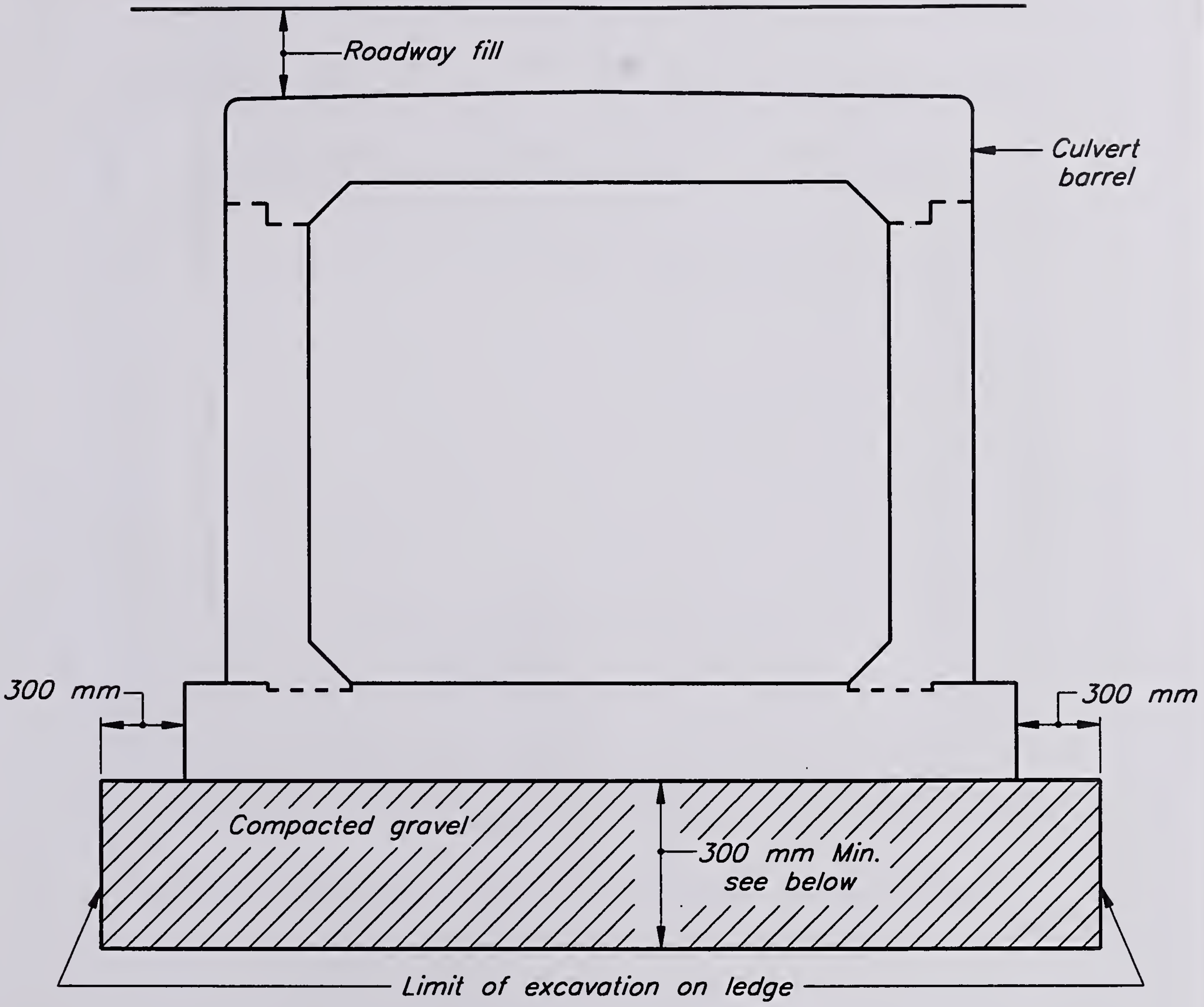
Plot Scale = 1:15

MASS HIGHWAY
BRIDGE
MANUAL

CULVERT JOINT DETAIL
AT WINGWALL
MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.3.5



NOTES:

1. If rock or other unyielding material is encountered at the elevation of the bottom of the foundations for reinforced concrete box culverts, the unyielding material shall be removed to a minimum of 300 mm below the bottom of foundations for depths of fill, on culvert, up to 7.5 m.
2. For depths of fill over 7.5 m the depth of excavation shall be increased 25 mm for every additional 600 mm of fill. The excavation shall be backfilled with gravel borrow compacted in accordance with section 150.* Where wingwalls are not integral with the culvert the over depth excavation will not be required.
3. * Also, see AASHTO test T-99 method D.

CULVERT STANDARD ON YIELDING FOUNDATION WHERE LEDGE IS ENCOUNTERED

Plot Scale = 1:25

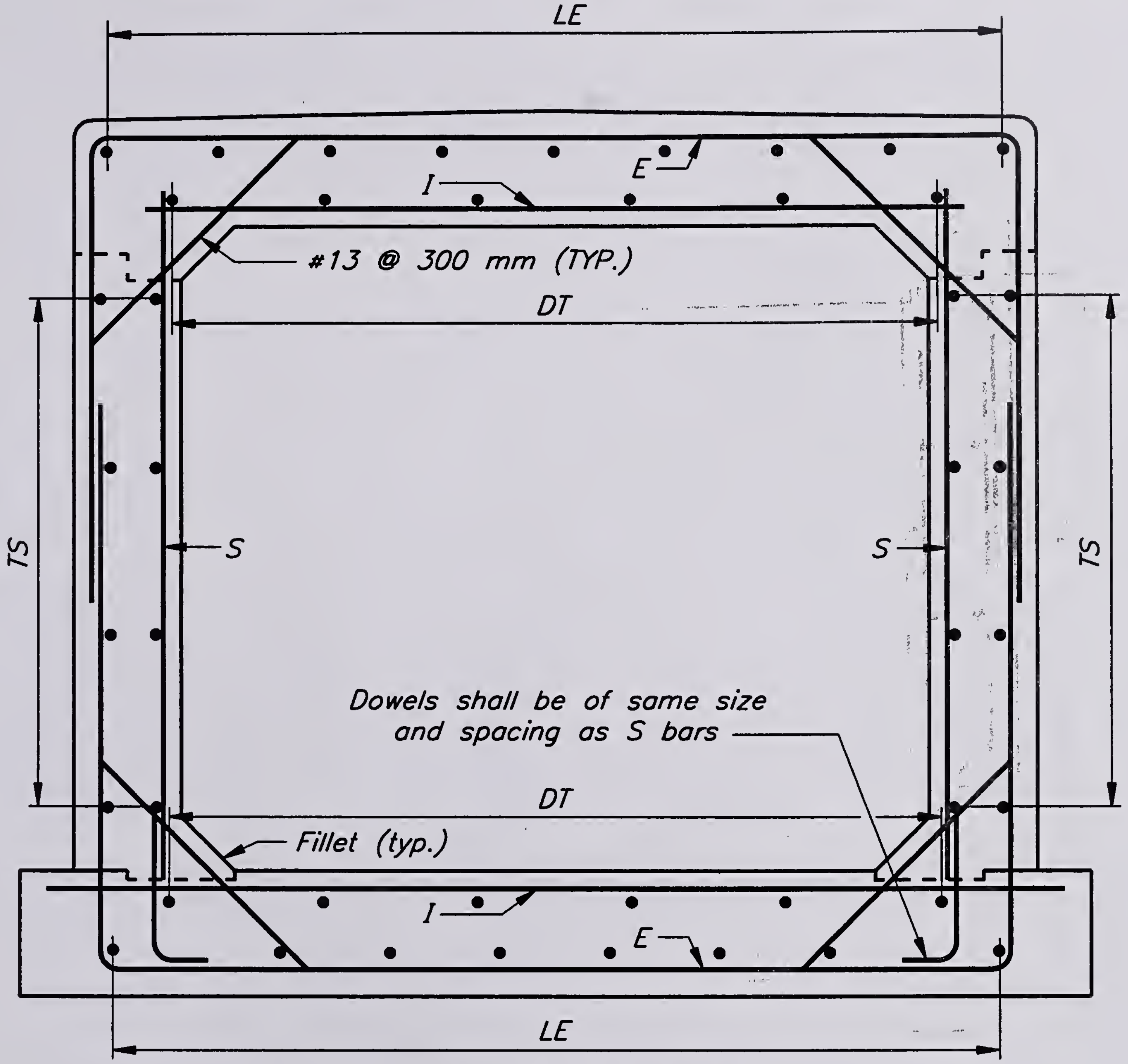
MASS HIGHWAY
BRIDGE
MANUAL

LEDGE EXCAVATION LIMITS

MISCELLANEOUS DETAILS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.3.6



TYPICAL SECTION

NOT TO SCALE

NOTES:

1. All culverts shall be:
   Assigned a culvert number when the horizontal dimension of opening is more than 2.4 m.
   Submitted for approval in accordance with "Sketch Plan" requirements of Bridge Section.
   Designed in accordance with the provisions noted in the written portion of this manual.
2. Where culverts are under high fills the Spec. Prov. should be explicit in the placement of backfill.
3. Culverts shown in these standards are not designed to provide for unbalanced horizontal forces. These forces shall be considered in the design of all culverts where conditions require.
4. For cases involving a cover in excess of 12 m an alternate design such as a reinforced concrete arch should be considered. Dimensions for culverts are for clear inside opening, horizontal dimensions given first. The volume of steel is not to be deducted from the volume of concrete when estimating quantities. This sheet to be used in conjunction with Dwg. No.s 11.3.1, 11.4.2, and 11.4.3.
5. A sufficient number of borings shall be taken for all culverts.
6. Steel reinforcement to be placed perpendicular to ℄ of construction.

Plot Scale = 1:20

MASS HIGHWAY
BRIDGE
MANUAL

REFERENCE SECTION
REINFORCED CONC. BOX CULVERTS

DATE OF ISSUE
DECEMBER, 1995

DRAWING NUMBER
11.4.1